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U.S. DEPARTMENT OF TRANSPORTATION

The Coast Guard Engineer's Digest

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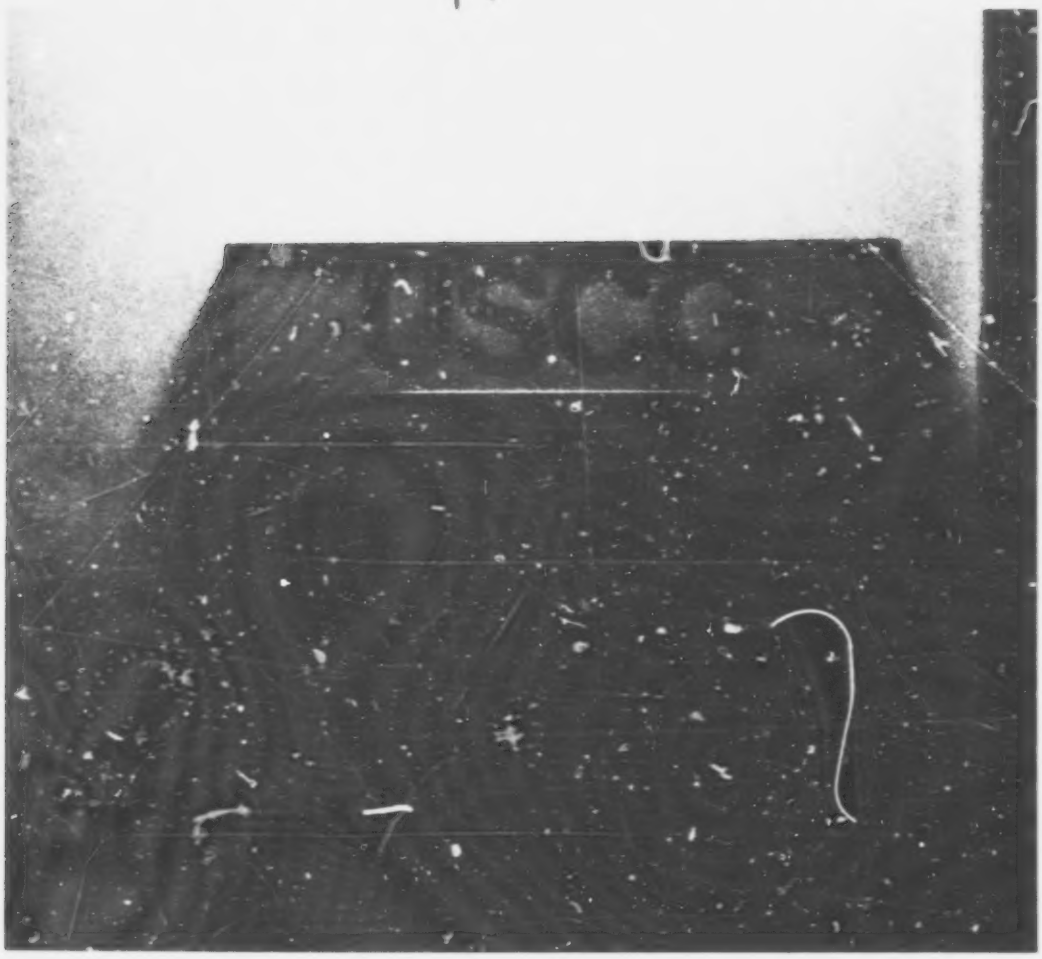

CG 133
Volume 20

Number 207
Summer 1980

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The Coast Guard **Engineer's Digest**

United States
Department of Transportation
CG-133

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The Coast Guard **Engineer's Digest** is an official publication of the Office of Engineering, U.S. Coast Guard Headquarters, Washington, D.C. Now published quarterly, the **Digest** has been a medium for communicating new ideas and technology of interest to Coast Guard engineers since April 1933.

The **Digest** is a professional journal for the publication of research papers, special studies and general interest articles aimed at advancing engineering in the Coast Guard.

While some material for the **Digest** is reprinted from other technical publications, most papers are submitted from the field by Coast Guard engineers and engineering managers, both military and civilian.

The Office of Engineering encourages all Cost Guard personnel in engineering-related fields to share their ideas and experiences, successes and failures, with the Coast Guard engineering community by submitting articles and papers for publication in the **Digest.**

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- Original articles by Coast Guard personnel (civilian and military) should have a byline, giving name, title, and unit, and a short biography of the author.
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Send articles, letters, photographs, suggestions, etc., to:

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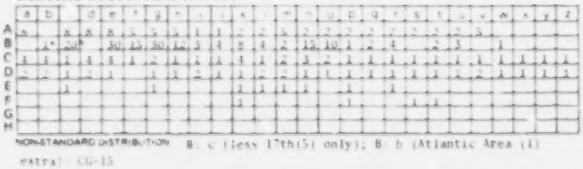

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FRONT COVER—The new enlisted berthing area in Boston. See article on page 11.

Coast Guard Engineering; The Next Decade

RADM D. C. Thompson
Chief, Office of Engineering
U.S. Coast Guard Headquarters

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Engineering challenges in the Coast Guard today are more substantial and diverse than ever, creating many opportunities for innovative professional achievement. The capital assets of our plant are nearly $11 billion and much of this plant is approaching the end of its useful life. This condition requires a capital investment of nearly $600 million annually just to replace or rehabilitate aging operational platforms, shore facilities, and electronics installations. This investment includes only replacement needs, not expansion.

To identify our engineering requirements for the 1980's, Cutter, Aviation, and Shore Facilities Plans have been updated and projects prioritized for the 1980's. To implement our plans, the Coast Guard has five engineering disciplines—naval, civil, aeronautical, electronics, and ocean—to oversee plant acquisition, construction, and rehabilitation.

Naval Engineering

The Naval Engineering Division at Coast Guard Headquarters, Washington, D.C.; the Coast Guard Yard, Baltimore, Maryland; the two Resident Inspection Offices; and the 12 district office Naval Engineering Branches are responsible for the design, construction, and maintenance of 248 cutters and 2,000 boats. The recent annual appropriation for this program has been $120 million for new construction and $36 million for maintenance. The largest staff element is at Headquarters, where ship design is accomplished and over 100 military and civilian Naval Engineering personnel are employed.

The Support Program at the district level consists of executing major maintenance to cutters and supervising vessel operational maintenance. Funds are distributed to the field units through the Vessel Program Budget which is based on the number, size, and type of cutters in each district. Other responsibilities include overseeing ship overhaul availability work lists that involve major maintenance or alterations.

The Coast Guard Yard, with its 1,100 personnel, is a major industrial facility where ship construction, conversion/rehabilitation, repair, and support activities occur. Ordnance and electronic overhauls are also done. The annual operating cost is $31.6 million.

Resident Inspection Offices are established at commercial construction sites for cutters and most boats. These offices are responsible for approving detailed construction drawings, inspecting the quality of workmanship, certifying progress payments, and supervising the installation of government-furnished equipment.

Two major acquisitions are under way. The 270-foot medium endurance cutter will meet the needs of an economical and reliable ship for law enforcement, search and rescue, marine environmental protection, and military preparedness. Thirteen such vessels will be constructed by 1985. Their design incorporates time-proven hull and machinery systems for reliability; the sensor, weapons, and command and control system embrace technologies for service well beyond the 1980's. The 270-foot class will have a 7,000-hp diesel engine with a maximum speed of 19.5 knots and a cruising range of 3,850 miles. Features include a computer-based command and control system; sensors to detect, track, and identify fishing vessels at long range; and a

flight deck which can handle the Coast Guard's new short-range recovery helicopter and the Navy's current and proposed antisubmarine warfare helicopters. There are living spaces for a crew of 15 officers, 10 chief petty officers, and 84 enlisted personnel.

Construction is under way on six 140-foot icebreaking tugs (WTGB's) which will replace the existing 38-year-old, 110-foot class vessel. This class vessel has a maximum speed of 14.7 knots and a cruising range of 4,000 miles. The diesel electric propulsion system that develops 2,500 shaft horsepower provides continuous icebreaking capabilities of 18 to 20 inches of hard, freshwater ice. From advanced design and model testing, a unique air lubrication system was developed in the hull which assists in extricating the WTGB from ice and improves the cutter's icebreaking capability. The ship will carry a crew of three officers, two chief petty officers, and 12 enlisted men.

The next major ship procurement planned is a dual-draft icebreaker that will be able to operate on the Great Lakes and in the eastern Arctic. The design is still in the conceptual stage, but engineering data should be available during mid-1980. Construction is planned to start in FY 1981 at an estimated cost of $80 million. This vessel will be the first in a class to replace the two remaining *Wind* Class icebreakers inherited from the Navy.

Naval Engineering officers and enlisted specialists are assigned to every cutter to operate the sophisticated engine rooms. Although new procurements are under way, we will continue to rely on our Naval Engineering experts in the field to keep the ships and boats running to meet our operational commitments.

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Figure 1. The *Bristol Bay* is the second cutter in the Coast Guard's new class of icebreaking tugs. Named for the body of water formed by the Alaska Peninsula which empties into the Bering Sea. Her operating area is Western Lake Erie, Detroit River, Lake St. Clair, St. Clair River, and Southern Lake Huron.

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Figure 2. Newly commissioned 140' Harbor Tug *Bristol Bay*.

In the next few years, naval engineers will be active in performing mid-life renovations on high and medium endurance cutters, designing a new class of ocean-going buoy tender, renovating the icebreakers *Mackinaw* and *Glacier* to extend their service lives, continuing major renovations of the seagoing buoy tenders, modernizing the 95-foot patrol boats, and constructing 41-foot utility boats and a new class of surf rescue boat.

Civil Engineering

The words that best describe today's Civil Engineering Support Program are "Total Facilities Management." This means managing the shore plant from its design to the end of its useful life. The civil engineer is involved in each of the seven functions which comprise the shore facilities management cycle.

The management system required to carry out the cycle evolved in the 1970's and provides for development plans to be published for major shore units. Several have been completed and many more are under way. The plans, plus inputs of specific needs for our many smaller units, are incorporated into a Shore Facilities Requirements List (SFRL) which is the heart of the Shore Facilities Plan. The SFRL provides an overview of the Coast Guard's needs over the next 10 years in regard to major construction and rehabilitation projects.

During the past few years, acquisition, construction, and improvement (AC&I) funds have been extremely sparse, due to the need to program most of these funds for cutter and aircraft replacements. Until this situation changes, major renovations will be done with operating funds. These projects include dredging, waterfront repairs, barracks rehabilitation, and recycling existing buildings.

By the early to mid-1980's, the major portion of acquiring new operational platforms will be completed and a new cycle of construction ashore is expected to be implemented. In the meantime, with a scarcity of construction funds, our Facilities Engineers face a tremendous challenge in maintaining the shore plant until new waterfront facilities, utilities systems, and building replacements are funded.

Many of the Long Range Aids to Navigation (Loran) C stations and transmitting towers are over 20 years old and will need renovations. Contracts will be let for rehabilitating buildings, replacing major tower components, and painting stations located throughout the world. With the pending takeover of the operation of the Navy's Omega Worldwide Navigation Program in the early 1980's, additional tower work will be programmed where structures are nearing mid-life.

Aeronautical Engineering

The Aeronautical Engineering field consists

Figure 3. Shore Facilities Cycle.

of a Division at Headquarters; an Aircraft Repair and Supply Center (AR&SC) at Elizabeth City, North Carolina; two Aircraft Program Offices; and the Aeronautical Engineering Departments at each of our 27 Coast Guard air stations.

The Aeronautical Engineering Division is responsible for planning and designing new aircraft. It assists the Comptroller in all phases of aeronautical systems contract negotiations, and it is also responsible for managing the Coast Guard Aircraft Maintenance Program.

Funds for aircraft and avionics maintenance are distributed annually to the field units for the upkeep of some 177 aircraft with a capital value of $1.1 billion. Engineering officers at each air station manage the maintenance personnel, supporting services, and funds necessary to execute a sophisticated computerized maintenance system for assigned types of fixed and rotary wing aircraft.

An AR&SC is a major support facility which overhauls, does major repairs to, and modifies aircraft and aeronautical equipment. It also provides for procurement, storage, inventory management, accounting, issuing, and shipping aircraft supplies, parts, and aeronautical equipment to the air stations. The annual budget of $37 million is used to overhaul 25 Sikorsky Model HH-52A and 12 Model HH-3F helicopters per year and to procure and stock aircraft parts.

Two major aircraft procurements are under

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Figure 4. Aerospatiale Helicopter Corporation Short Range Recovery Aircraft.

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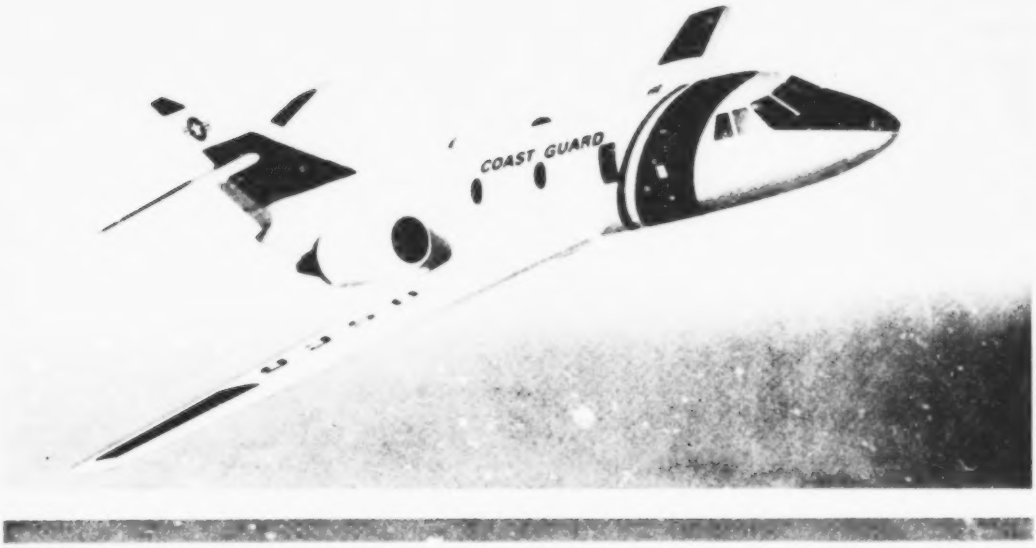
Figure 5. Falcon Jet Corporation HU- 5A Medium Range Surveillance Aircraft.



way. The Sikorsky HH-52A helicopter has been in service for over 16 years and is no longer considered economical to maintain. A contract for $215 million was recently awarded to construct 90 short-range recovery (SRR) helicopters to replace the HH-52A. The first helicopter is scheduled for delivery in 1982 and will be configured for multimission purposes. It will be used primarily for search and rescue/recovery but will also be involved in enforcement of laws and treaties, marine environmental protection, and marine science activities. The maximum speed is 160 knots with a range of 420 miles and an endurance of 4.1 hours. A sophisticated avionics package with the latest in communications, navigation, and search equipment will be installed in the all-weather, fuel-efficient, twin turbine engine aircraft. To administer the contract and test fly the aircraft, an Aircraft Program Office has been established at the contractor's facility.

The aging HU-16 Grumman "Albatross" and C-131A fixed wing aircraft will be replaced by HU-25A medium-range surveillance aircraft. A contract was awarded in 1977 for 41 planes at a cost of $205 million. The first aircraft is scheduled for delivery in late 1980. It will be used for search and rescue, pollution surveillance, and coastal and offshore law enforcement patrols. It will have a maximum cruise speed of 470 knots; its maximum range is 2,045 miles and it will have an endurance of six hours.

Electronics Engineering

Electronics Engineering is structured along the same lines as the Naval and Civil Engineering Headquarters staff. Coast Guard electronics engineers are responsible for designing new electronic systems used in communications and navigation ashore and afloat; they also oversee the management of electronic equipment maintenance programs.

To carry out maintenance and administer contracts, Electronics Engineering

Branches are located in all district offices. The Electronics Engineering Center, Wildwood, New Jersey; the Electronics Laboratory at Station Alexandria, Virginia; and the Electronics Repair Branch at Supply Center, Brooklyn, New York, work directly for Headquarters and are responsible for testing and evaluating electronics equipment and facilities. The current annual appropriation for the electronics program is about $24 million in OE and $26 million in AC&I funds.

One of the primary areas of concern within Electronics Engineering is the Loran-C program. This system has been in operation for the Department of Defense since 1958. In 1974, Congress mandated that the Loran-C radio-navigational system be used in the adjacent U.S. continental coastal

Figure 8. 1980 Loran-C coverage.

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confluence zone, the Great Lakes, the Gulf of Mexico, and Alaskan waters. Twelve new loran stations have been built since 1974 and another will be completed in March 1980. The Coast Guard is also working with the Canadian Government to provide additional coverage along the New England coastline and the Canadian east and west coast areas.

One challenge of the 1980's will be to provide expanded Loran-C coverage with greater economy. Modular solid-state equipment with improved accuracy and reliability developed in the 1970's will be produced in the 1980's to replace much of the vacuum tube transmitting and control equipment. Operational costs will also be reduced by removing all personnel from monitor stations and by using remote-control techniques at these stations.

The new 270-foot cutters require a sophisticated computer system for bridge operational control. The Command, Display, and Control System that uses three Navy standard AN/UYK-20 computers, multiple-disk drives, and special-purpose peripherals will enable operators to have greater command and control capabilities under both peace- and war-time missions. The shipboard equipment console layout includes modern gunfire, sonar, radar, video, and various weapon control systems.

Ocean Engineering

The Coast Guard's Ocean Engineering Program is located primarily at Headquarters, with only a few personnel

Figure 7. Shipboard Command, Display and Control (COMDAC) System.

Figure 8. Open water oil containment and skimming barrier.

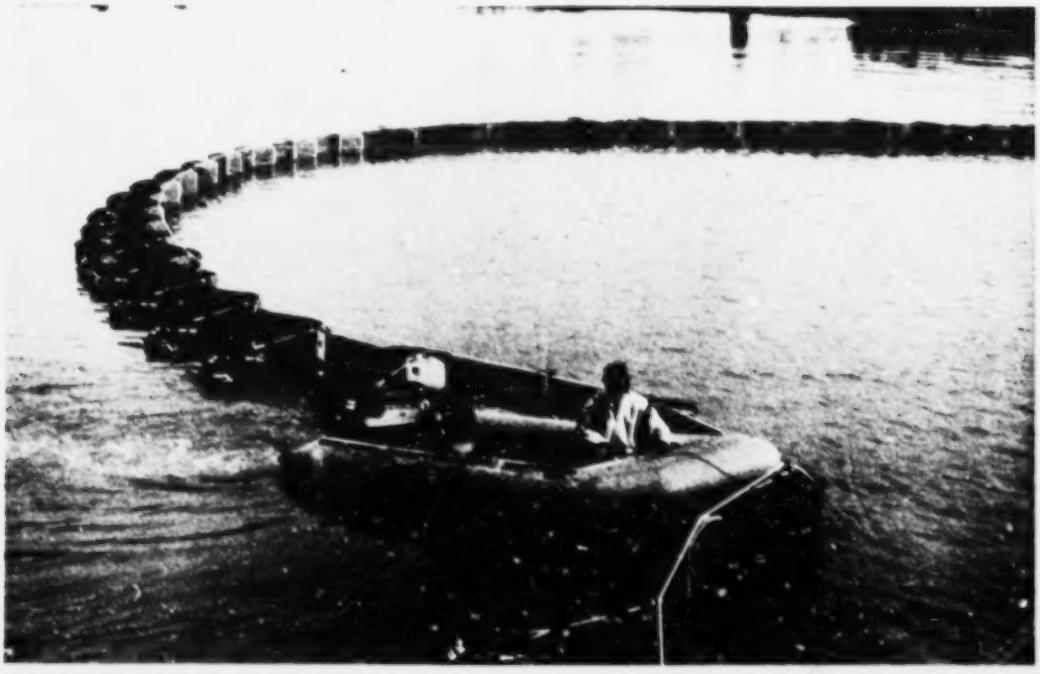

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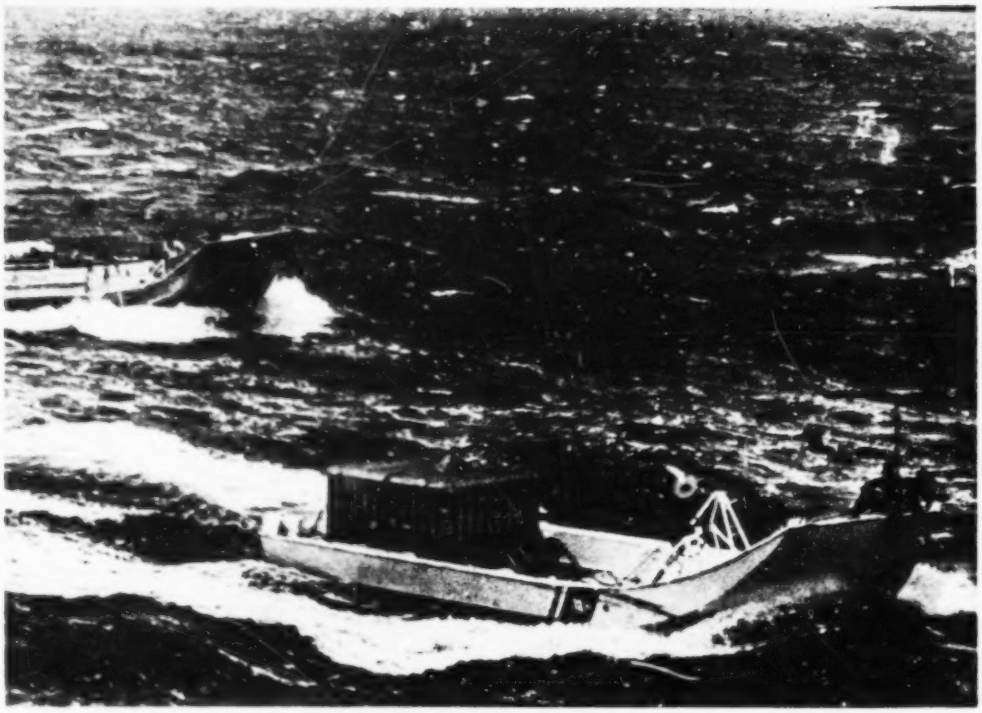
Figure 9. Fast Surface Delivery (FSD) Sled.



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stationed in district offices. Development and hardware acquisition in the fields of pollution cleanup and solar energy powered aids to navigation will be of major concern in the 1980's.

Three regional Strike Teams provide the Coast Guard with the manpower and equipment needed to respond quickly to major offshore oil spills. Ocean Engineering assists in furnishing new pollution response hardware for these teams. A major project for the coming years is the skimming barrier and its predecessor, the open water oil containment system. Much work remains in producing simplified operation and maintenance procedures and equipment modifications. This system represents advanced developments in both containment booms and offshore skimming devices.

Another component of the skimming system is a closed containment barge to store the oil/water mixture. Due to the limited availability of conventional barges on short notice, collapsible containers that can be towed to the scene are being acquired. The largest of these is the 240,000-gallon Dunlop Dracone barge. These barges are vital to the operation and are used for temporary storage until lightering vessels arrive or they can be towed to the disposal site.

To deliver the pollution equipment, a fast surface delivery (FSD) sled was developed with up to 20,000-pound payloads. The sled is towed to the polluted site by small boats and equipment is deployed with a minimum of weight-handling gear by having the stern of the sled sink (take on ballast).

Ocean Engineering is also involved with photovoltaic technology for the Coast Guard's 14,000 minor aids to navigation. The Department of Energy is funding a $1 million grant in 1980 to help accelerate the

design and implementation of solar power for fixed aids and buoys. As part of the over-all program, a series of six 150-foot-tall light structures along the Florida Keys will have a new light signal and power supply. These structures are primary aids to marine traffic transiting the Straits of Florida. The hardware will provide a 19-mile light signal—a significant improvement over the present system—by a low-voltage, direct-current (d.c.) flash tube. The power supply will be secondary batteries charged by photovoltaic arrays of 200-watt capacity. The first installation is scheduled for 1980, and all six lights should be operational by early 1981. The successful use of low-voltage d.c. flash tubes and large photovoltaic power systems could open a whole new area of applications in aids to navigation in the next decade.

Conclusion

The 1980's promise to be an interesting period for Coast Guard engineering. Our multimission requirements dictate that we continue to replace aging cutters and aircraft. Expanded Loran-C coverage throughout the United States and Canada will be provided. Research and development in Electronics and Ocean Engineering will provide new systems that will improve performance while reducing maintenance and operating costs. The challenge for our civil engineers will be to keep the Coast Guard's aging shore plant intact and be prepared to implement an increase in construction ashore to accommodate the new systems and platforms being produced by the other engineering fields.

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Enlisted Berthing in Boston

Mr. Ronald N. Katen
Civil Engineering Branch
First Coast Guard District

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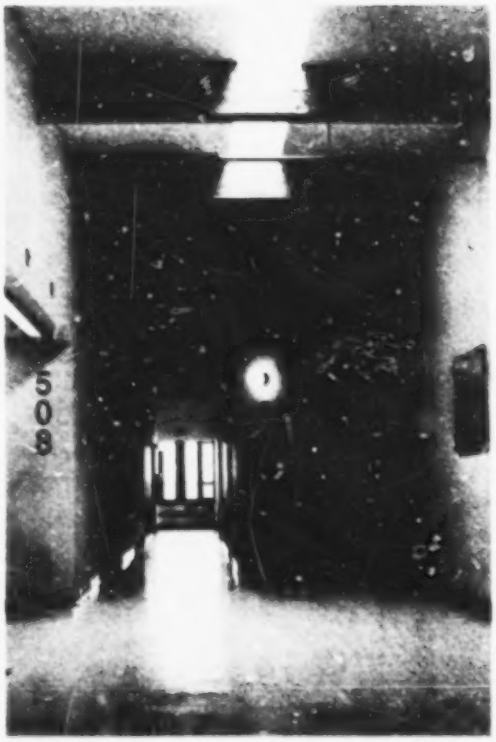
The First Coast Guard District recently completed construction, in downtown Boston, of a new Berthing Facility for enlisted men and women. This facility is located at CG Support Center, Boston, and is a noteworthy project because of its setting and its design.

The project was done entirely "in-house" by the First District Civil Engineering design staff, and was executed in conjunction with an overall Development Plan for the Support Center. This base is one of the primary Coast Guard facilities in the First District. As such, it provides administrative support for tenant commands, and industrial support for major and minor units in the surrounding area. The base, itself, is located along Boston's historic waterfront district and lies at the edge of the North End. It is only a few blocks from the federal, state, and city Government Center complex, the much-publicized Quincy Market, the new waterfront Park, and many of the warehouses-turned-into-apartments which have been highlighted recently in magazines such as *HOUSING* and *ARCHITECTURAL RECORD*. The base consists of five major buildings mostly 80-100 year old warehouse-type structures common to the waterfront district. The approved Development Plan for the base follows the recommendations of a feasibility study recently done for the Coast Guard by a local A/E firm. Certain portions of the proposed work will be done "in-house" by the First District design staff, while the remaining work will be contracted out to a local firm. Total cost for the planned redevelopment will be approximately $16,500,000.00.

One of the first "in-house" projects undertaken as part of this overall Development Plan was the design of new berthing quarters for enlisted men and women. For the three-year period immediately preceding completion of this project, no permanent on-base berthing existed. Prior to that, CG personnel were housed in delapidated, substandard quarters dating from shortly after WWII. Since CG Base Boston is located in an urban setting, this project afforded a rare opportunity to provide "Hi-Rise" berthing as compared to the standard 2- or 3-story barracks or garden-type facility most often used. In addition, this was a rehabilitation project rather than new construction, in keeping with recent Federal guidelines encouraging rehabilitation of existing



structures. The total berthing project encompasses several separate construction phases, the first of which was completed in June 1979. This phase consisted of renovating the top floor (15,500 sq.ft.) of a 5-story warehouse building, used for many years as a chocolate factory. This building has brick exterior bearing walls and heavy timber construction throughout.

Flexibility in developing the design layout was constrained by three factors:

(1) Minimum required sq.ft. of living space per person;

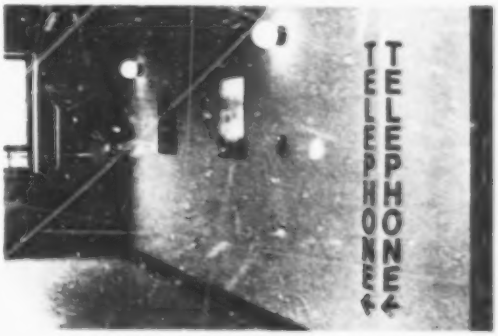
(2) Existing, closely spaced structural columns; and

(3) Existing window openings.

Consequently, the proposed design evolved around these three items. The overriding design concept was to provide bright, cheerful surroundings which would be uplifting to those using the facilities and thus be a definite morale booster.

The entire project area was first gutted, leaving only the existing wood columns and masonry window openings in place. The original 5'0" wide × 8'0" high, arched-top, double-hung wood windows were removed, the opening height decreased, and new combination casement/projected windows installed. An insulated infill panel was used above the new windows to compensate for the decreased height. Many of the existing wood columns and overhead wood beams were sandblasted and left exposed, as was some of the original brickwork. No change was made to the exterior appearance of the building.

Aesthetically, the intent was to provide a finished interior appearance which would be opposite to the stereotyped version of military architecture. Thus, dark spaces and monotone colors were avoided. Instead, skylights were used to introduce natural light to the central corridors, the corridor walls themselves were designed with projections and recesses to visually make them seem larger and less hall-like, plants and foliage helped to bring the outdoors in, and contemporary graphics (to include wall murals, framed paintings and a complete sign system) helped to brighten the "public" areas. Four separate color schemes for the bedrooms and two for the bathrooms were used on this project. The color variety helped to create both a sense of individuality and a feeling of warmth for the residents.



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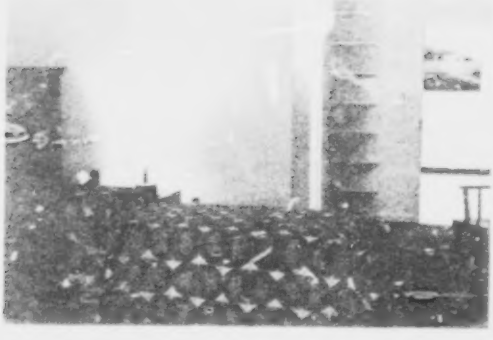
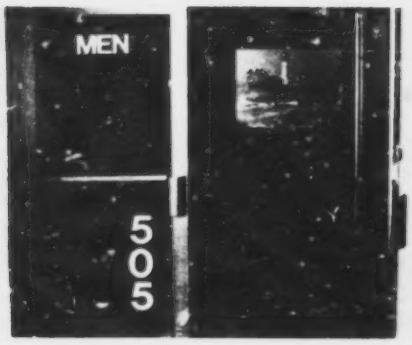


Technically, all new utilities were tied into existing systems. The heating system was a forced hot water, wall-mounted, convector unit type, with individual room thermostats. Fire protection was provided by an active sprinkler system, ionization-type smoke detectors with fire indicator lights above each bedroom door, and by two separate Fire Department standpipe hose installations. Sound isolation was achieved by using acoustical partitions between all bedrooms. Energy conservation features included the use of insulated exterior walls, double-pane insulating glass in all windows, and water-saving devices on all showerheads and bathroom faucets.

The finished project provided predominantly 2-person bedrooms, with shared adjoining bathroom, and was able to accommodate 53 men and 10 women. Construction of additional berthing facilities at the Support Center is planed, and will be accomplished under future construction phases of the Development Plan. Areas scheduled to be converted into berthing include portions of the two floors directly below the area just completed, as well as the top three floors of a contiguous building. The design scheme for the 5th floor of this contiguous building was prepared concurrently with the PHASE I design and is, essentially, an extension of that layout. Once these new berthing facilities are constructed, they will provide quarters for an additional 120 persons. The lower floors in both buildings will also be subsequently renovated, and will provide new administration, recreation, and support spaces.

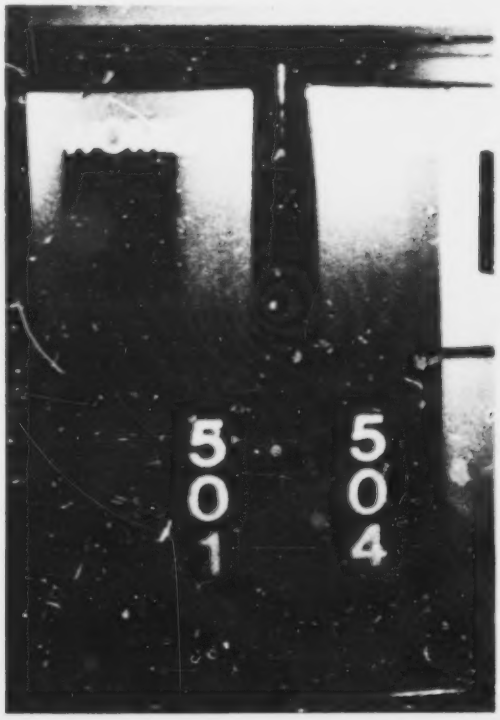


Phase I of the new Berthing Area was completed in June 1979, at a total cost (including furnishings) of $600,000.00. It was opened for occupancy one month later, and has been extremely well received by both occupants and management.

About the Author

Mr. Ronald N. Katen has been employed as an architect with the 1st District for five years, prior to that, he worked for civilian architectural firms in N.Y.C. and Washington, D.C.

He is a reserve officer with the U.S. Army Corps of Engineers with the rank of Captain. He has served on active duty with the Corps of Engineers for four years, with assignments in both Korea and Vietnam. Mr. Katen has a B.S. from C.C.N.Y., New York City; B. (ARCH) from C.C.N.Y., New York City; and an M. (ARCH) from Harvard University, Cambridge, MA. He is a registered Architect in New York and Massachusetts and holds an N.C.A.R.B. certificate (National Council of Architectural Registration Boards).



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Commandant's Comments

Some very tough problems were identified and analyzed, and a well-conceived design to solve these problems was developed. Mr. Katen's article presents an excellent case for rehabilitating an existing building rather than constructing anew, especially when considering costs and aesthetics in Boston's historic waterfront district.

SUPRTCEN Boston's Development Plan was approved on 4 October 1979, and provides a guide for future construction phases including additional berthing facilities.

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Strike Force in the Bay of Campeche

As our energy-hungry world prepares to enter the 1980's, it has become necessary to probe further than ever to find the needed resources to feed our economic machinery. The complexity of the methods used in this search for energy resources has increased; so has the risk of mistakes and accidents.

These circumstances have created the formula for inevitable pollution incidents. When such incidents occur, they must be dealt with effectively if their environmental impact is to be minimized.

In accordance with the National Oil and Hazardous Substances Contingency Plan, the United States Coast Guard, in 1972, created the National Strike Force (NSF) to provide instant response capabilities for, "Federal action to minimize pollution damage from discharges of oil or hazardous substances." This NSF is composed of three 28-member teams. The Atlantic, Gulf, and Pacific Strike Teams have come to be recognized as the world's foremost pollution response force.

The magnitude of the June 3, 1979, blowout of the Ixtoc I oil well in Mexico's Bay of Campeche provides a dramatic illustration of why the Coast Guard's NSF has earned the enviable reputation of being the world's best at what they do.

On August 4, 1979, Lieutenant Commander James O'Brien, Commanding Officer of the Pacific Strike Team stepped off a Coast Guard C-130 (Hercules) cargo plane in remote Ciudad del Carmen, Mexico. The bright, early morning tropical sun did not create any illusions of vacation in paradise, however, for O'Brien fully realized the monumental task he and his men faced.

Less than 48 hours before, he had been working at Pacific Strike Team headquarters in San Fransico when he received orders from Coast Guard Atlantic Area Commander, Vice Admiral Robert I. Price, to proceed to Ixtoc I. To carry out this order, O'Brien coordinated the loading of 40 tons of equipment aboard three Hercules cargo planes. He and his men then proceeded to Ciudad del Carmen where they joined forces already assembled by Petroles Mexicanos (PEMEX), the Mexican state-owned oil company, at the blownout well, 50 miles from shore in the Bay of Campeche.

Even as the six Coast Guard Strike Force members were transferring their gear from the cargo planes to the work boat *Star Light*, patches of oil began entering U.S. waters off Brownsville, Texas, 500 miles northwest of the wellhead. Here, other strike force members were establishing a mobile command post at Port Isabel, near Brownsville. Still other strike force personnel were deploying oil containment booms in strategic places along hundreds of miles of south Texas shoreline, as state and federal officials and scientists were working 16-hour days at the Federal On-Scene Coordinators command post in Corpus Christi, Texas, preparing for any and all impacts on the ecologically sensitive U.S. Gulf Coast.

O'Brien was well aware of the job he, his men and equipment faced in the Bay of Campeche. He had been part of a special six-man mission which visited Mexico City in July to discuss means of U.S. assistance. While there, he visited Ixtoc I and the enormity of the situation was quite apparent. An estimated 1,260,000 gallons of crude oil was escaping daily into the Gulf of Mexico, and the total amount spilled had surpassed the *Amico Cadiz* disaster, making Ixtoc I the worst oil spill in history.

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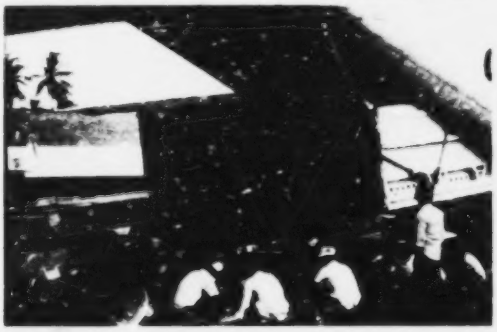
The special mission also learned why the well blew out. Mexican Attorney General Oscar Sanchez explained that the basic cause of the blowout was the discovery of an unexpected underground cavity 11,775 feet below the seabed. According to his statement, when the drill penetrated the cavern, it fell about three feet, cracking a thin layer of rock that capped a very rich deposit of gas and oil. With pressures in the formation estimated at 6,000 pounds per-square-inch, the gas and oil roared into the fracture, causing the blowout.

The Open Water Oil Containment Recovery System

Once on scene at the wellhead, the Coast Guard team spent four days checking and preparing their equipment, as private contractors repositioned work barges and booms which had been blown off their stations by recent storms. On the fifth day, the strike team began deploying two 612-foot Open Water Oil Containment Recovery Systems (OWOCRS).

Although open water containment booms are common in the oil pollution cleanup business, this was the first time the new Coast Guard skimming system would be used on an actual spill. With each end of the

A Coast Guard C-130 discharges its load of Pacific Strike Team oil recovery equipment in remote Ciudad del Carmen, Mexico.



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An oil covered Chief Petty Officer Ron Brown of the Gulf Strike Team checks pumps used to transfer oil from the recovery boom to a waiting tank barge.

Three Coast Guardsmen of the Pacific Strike Team watch gas burning at the blown-out Ixtoc I oil well in Mexico's Bay of Campeche.

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612-foot boom moored to large sea anchors, the boom was set in a U-shaped configuration. The open top of the "U" faced the wellhead, directly into the path of the flowing oil. The bottom, or closed end, of the "U" held six skimming panels which removed the oil trapped inside the barrier. A floating pump, behind the skimmers, transferred the trapped oil to a waiting barge.

Many types of oil recovery devices ran into continuous difficulties with parting mooring and tension lines and equipment breakdowns. The oil recovery system designed by Offshore Devices of Peabody, Massachusetts, in conjunction with the Coast Guard Office of Research and Development, however, exceeded all design specifications for surviving the conditions experienced in the Bay of Campeche. Even in 12-foot seas and 40-knot winds, the system continued to recover oil.

As with any new piece of equipment put into operation for the first time, the OWOCRS required some minor modifications. O'Brien explained how the concept and complement of the NSF facilitated not only the correction of minor on-scene problems, but also prevented expensive, major design changes after the OWOCRS went into operation. "Members of the strike teams," said O'Brien, "have to be very inventive and adaptable. There were no parts stores next door to Ixtoc I, and the modifications made at the wellhead were the result of the remarkable ingenuity of the people who are the strike team."

O'Brien continued, "In regard to the OWOCRS, the NSF worked closely with the Coast Guard Office of Research and Development. Since ultimately we would be the ones who would use the OWOCRS, the strike force gave operator input during the developmental stages. This input helped to prevent the need for large, costly modifications once the system was put into operation."

The six Coast Guardsmen had to coax and muscle the 15,600 pound recovery system into position under a 95 degree tropical sun with the humidity ranging between 75 and 80 percent. "For four days we were soaked from the neck down in oil," recalled Damage Controlman First Class Dave Jago, "as we deployed equipment and wrestled with the 1,500 pound hydraulic hoses trying to hook them to the pump sled and barge. We could only work in two hour strecnes before the heat and exhaustion forced us to take a break."

It was during these OWOCRS deployment maneuvers, under such grueling circumstances, that most of the minor modifications were performed. Boatswains Mate First Class Rick Hudson proudly explained the initiative of his colleague, Dave Jago. "It quickly became obvious that some method of floation would have to be devised to take the strain off of the hose fittings between the skimming barrier, the pump, and the barge," said Hudson. He continued, "Jago can do anything with a torch. He was able to build, on-scene, a floation device for the hoses and the pump sled which increased the capability and survivability of the entire recovery system."

Once the OWOCRS was fully deployed, the six-man team kept it operating 24 hours a day for five days. The decision was made, however, to suspend night operations for safety reasons. "After the fifth day," said O'Brien, "sea conditions got so bad, we couldn't get on and off the barges. PEMEX asked us to secure night operations to insure the safety of the personnel. They were afraid someone might get hurt and I agreed. The normal pumping day then went from 5:30 in the morning to 7:00 or 8:00 in the evening."

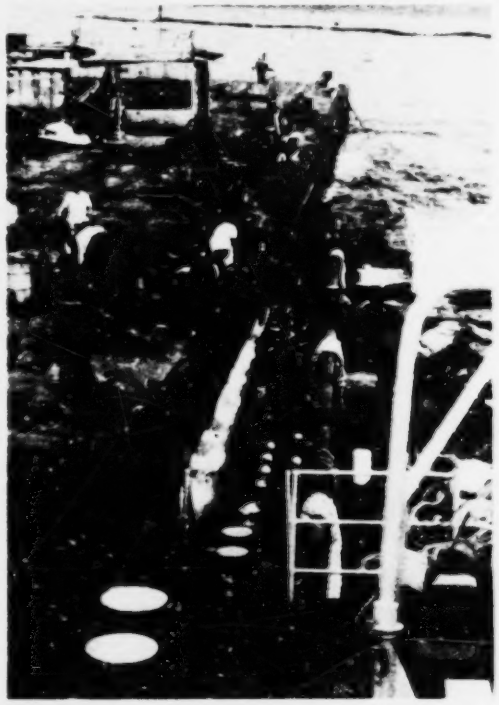
As for the performance of the Coast Guard equipment, O'Brien had high praise. "From a system standpoint," he said, "we were quite pleased. The OWOCRS survived tropical depressions and Hurricane Henri. We averaged between 300 and 400 gallons a minute recovery rate when we had oil in the barrier. I'd stand on the tallest building in the United States and tell you that it is the best barrier containment recovery system on the market for an open water situation."

Life At An Oil Spill

There were no days off and work days lasted fourteen hours or more. At the end of these strenuous days the Coast Guardsmen were usually too tired to enjoy the facilities aboard the 790-foot work barge *Sea Lion*. "We referred to it as the Holiday Inn *Sea Lion*," joked Machinery Technician Second Class David Garris, "meals were served four times daily, there were movies, an overnight laundry service, and even a salt water swimming pool aboard *Sea Lion*."

To the American Coast Guardsmen at the Ixtoc I well, the support they received from the United States was not only vital, but also extremely impressive. "Many of the things we would suddenly need at the wellhead could not be quickly obtained in Mexico," said O'Brien, "Whether we needed moving parts, or coils of line or outboard engines,

A Coast Guardsman leaps from the deck of the *Star Light* to a work barge in Mexico's Bay of Campeche.



all I had to do was get a phone patch through to my boss, Commander Jerry Bacon in New York City. No matter how difficult or minor the request, he and his people located the source of supply, purchased the item, got it to its shipping point and had it in our hands, usually within 24 hours."

"You don't anticipate a lot of breakdowns, but when they occur, the sense of panic doesn't set in because you know in the back of your mind, 'well, gee, all I have to do is pick up the phone and within 24 hours I'll at least have it in Ciudad del Carmen, just a boat ride away'."

To men who have worked on some of the largest oil spills in the world in places such as Chile, Singapore, Bogota, Rio de Janerio, and the North Sea, the Coast Guardsmen who worked at Ixtoc I were not overwhelmed at the thought of responding to the world's worst oil spill.

However, there was one lasting impression that each man seems to have come away with. The tropical sunsets would paint an incredible vision across the sky, and the coming darkness would accentuate the dancing flames directly over the wellhead. LCDR O'Brien summed up the common thought of each of his men. "How could something so ugly during the day, when we were in it up to our necks, become such a beautiful sight at night? I would stare at the flames at night and the impact of the sight would remind me of the fury of nature that can be unleashed when men make truly big mistakes."

Commandant's Comments

Again, the Pacific Strike Team in particular and the National Strike Force generally, have outdone themselves. Ocean Engineering Division at Headquarters followed the "on-scene" engineering design and reconstruction modifications required with amazement. The documentation provided by LCDR O'Brien is already being used to enhance equipment design for future procurements. The support provided by Commander, Atlantic Area, is also noteworthy as these behind-the-scene efforts are always critical and frequently not acknowledged. Exception to the words "minor modifications" is taken, since they involved design, fabrication, testing and evaluation accomplished in a 24-hour period by a small work force speaking five different languages. Kudos to the whole NSF organization.

Adding its own illumination to the tropical sunset, gas released by history's largest oil spill burns in Mexico's Bay of Campeche.

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No More Ma Bell

LT Rick Bartlett
Civil Engineering Branch
Second Coast Guard District

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In March 1975, the Engineering Division of the Reserve Training Center (RTC) in Yorktown, Virginia, undertook a study to determine the adequacy of and possible improvements to the Center's telephone system. The results of the study, which was completed in May 1976, revealed that there was a definite need to upgrade the existing RTC telephone system.

The existing telephone system was found to be deficient in both expansion capabilities and service. As of May 1976, 166 of the available 200 lines were being utilized; this figure represented a 30-line increase since 1974. The pending completion of a new training building would require more than the available 200 lines. Expansion of the system beyond a 200-line capacity could not be accomplished without increased costs for installation of additional switching equipment. Also physical expansion of the switching equipment room was severely limited because of adjoining medical and dental facilities.

The existing telephone system itself consisted of a 1940 era Model 552A telephone turret (see figure 1), mechanical step-by-step switching equipment (figure 2), 350 rotary dial telephone instruments and related key system equipment. The entire system was owned and maintained by a local telephone company, the Chesapeake and Potomac Telephone Company of Virginia. All the underground cable at the Center was Coast Guard owned and maintained.

As previously mentioned, maintenance of the system was provided by the C&P Telephone Company. The inconvenience of a mechanical switch breakdown was an everyday occurrence; age-related breakdowns of the switch accounted for approximately six (6) man-hours a week, and it was not uncommon to have the C & P Telephone Company repair personnel at the Center every day of the week. Since the capacity of the mechanical switch allowed for only twenty (20) on-base originated calls at one time, a problem with an individual component switch would reduce the calling capacity of the base by five percent for each line affected, and it was also not uncommon to have three component switches inoperative at one time. A jamming of any one switch would incapacitate the ENTIRE telephone system, thus NO calls could be initiated or received until the problem was corrected.

Due to the age of the existing telephone system, many present day communication features were not available to the Center. The antiquated system provided that all local or long distance non-FTS incoming calls had to be hand connected through the on-base operator on a plug-in cord turret. Work studies of the telephone operator's activities disclosed that at peak calling times (around 10:00 a.m. and 2:00 p.m.) she handled as many as 35 calls a minute, while also providing informational assistance. This operator also handled all outgoing long distance directory assistance calls, 800-number calls, and all outgoing calls from certain restricted telephones.

There were, apparently, three alternatives to this communication problem. The first, obviously, was to continue to use the age-old existing equipment with its constant problems and failures. This equipment was being rented from the C&P Telephone Company at a cost of approximately $40K per year (1978), a high price to pay for such antiquated and unreliable equipment. In addition, further costs would also be incurred to expand the system beyond the previously mentioned 200 line capacity.

Figure 1. Existing 1940 era telephone switchboard

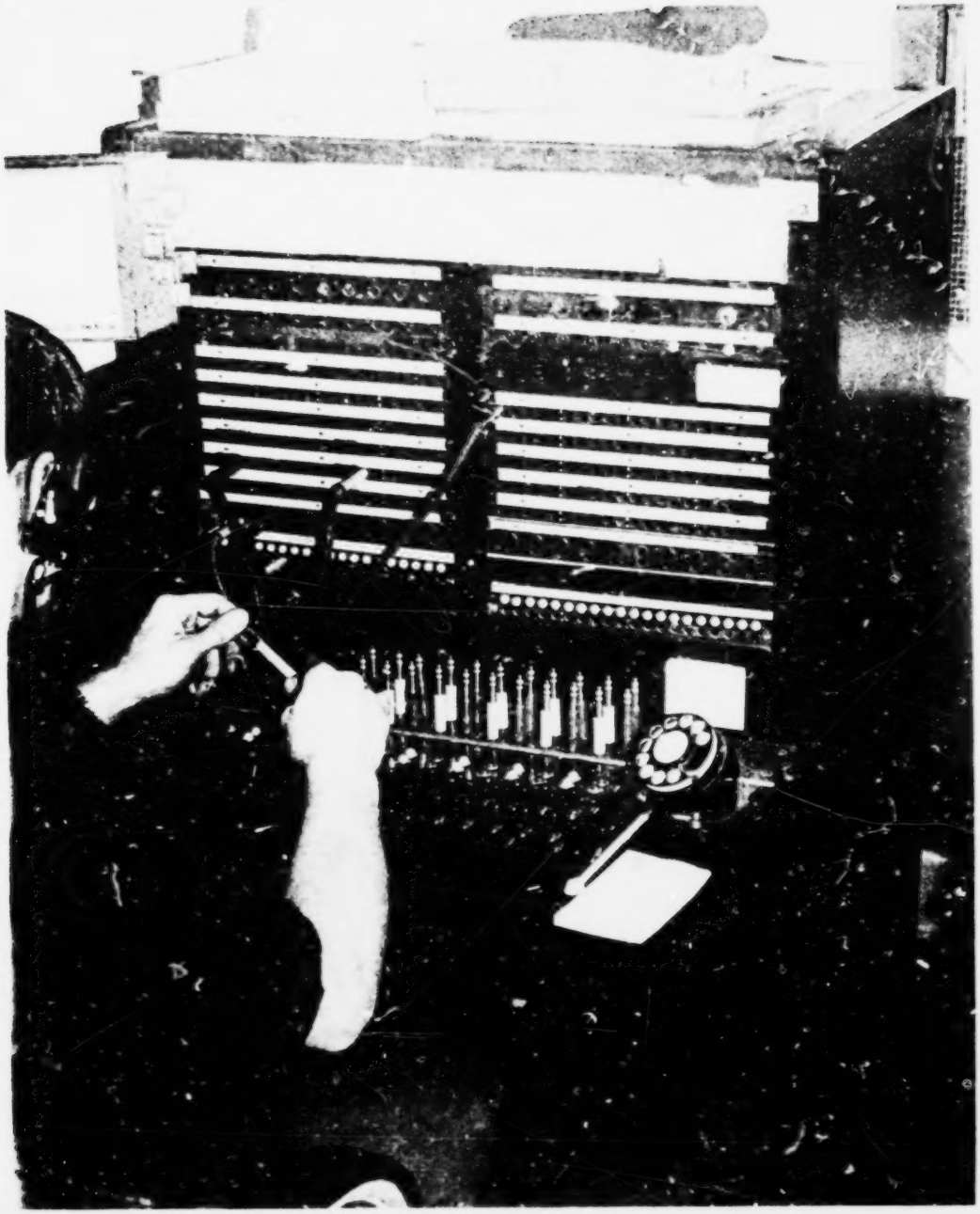


Figure 2. Existing mechanical switching equipment.

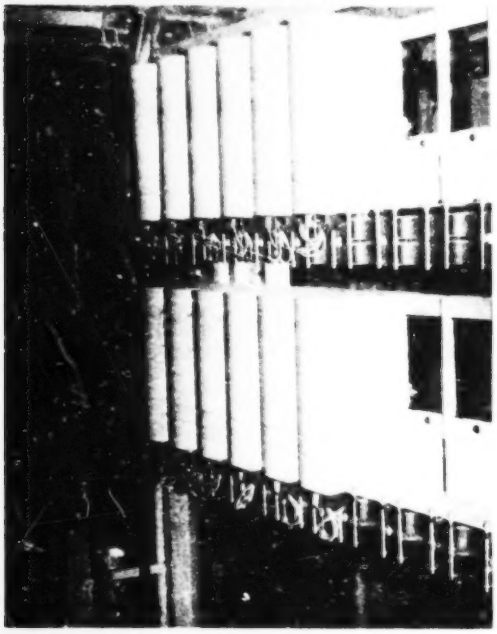
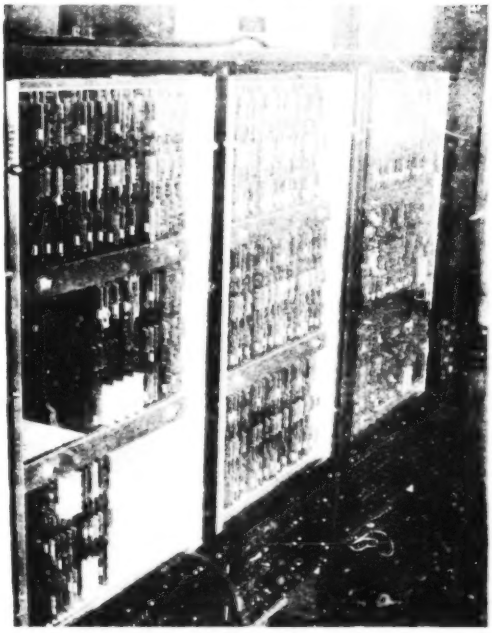


Figure 3. New electronic switching equipment.



The second alternative was to upgrade the system with the C&P Telephone Company PABX Direct-in-Dialing System (or CENTREX). This alternative would provide the Center with a modern state-of-the-art telecommunications system.

The third alternative was to purchase a telephone system with features similar to the C&P system. The possibility of a government owned system was based on a U.S. Supreme Court ruling in 1968 that private industry could compete with AT&T in the manufacturing of telecommunications equipment for both home and industrial use. Prior to this ruling, only telephone company's equipment could be used by the communications industry.

After thoroughly considering the second and third alternatives, we gathered the necessary cost data and submitted it to HDQTRS (G-OTM) for an A-76 analysis (a computer program for cost comparisons). The analysis compared a leased telephone system (the C&P Telephone Company System) to a Coast Guard owned system.

All data, costs, and cost estimates used in the analysis were those effective in September 1975. Data for a Coast Guard owned system was provided by the Stromberg-Carlson Company, manfacturers of telecommunications equipment.

The results of the A-76 analysis indicated that it might be cost effective for the Coast Guard to own its own system. Furthermore, if the Coast Guard purchased a telephone system, it would not require an increase in the billet structure at the Center, as maintenance of a new system could be accomplished by the first class petty officer who was filling the existing telephone technician billet.

With the results of the A-76 analysis for justification, we requested that (G-OTM) provide the funding in FY 77 in the amount of $80K for the purchase of a Coast Guard owned system. We also requested that (G-EEE) provide us with technical assistance in writing the specifications for such a system. It was anticipated that RTC would handle the contracting aspect of the

project.

Although (G-OTM) provided funding in FY 77, the lengthy process of preparing plans and specifications carried the project into FY 78. Complicating the project preparation were two AC&I building projects and an extensive renovation program of the buildings at RTC. This building renovation project at RTC made it almost impossible to set up specific requirements for telephone instrument locations and features. It wasn't until January 1978 that preliminary drawings and specifications were finally completed. In late February '78, a final review of the plans and specifications was conducted, and appropriate changes were made to the project.

The intent of the project was to have prospective contractors bid on a sale or lease of the equipment to the Coast Guard with an initial one-year maintenance agreement included. After the initial year, if it was economically feasible, the Coast Guard could assume the maintenance of the system. The solicitation was therefore written on the basis of a lease, purchase, or lease with option to purchase. This would allow the C&P Telephone Company to submit a bid on the project on the same terms as commercial companies.

The bids were to be submitted on any and/or all categories, i.e., lease, purchase, or lease with option to purchase. All bidders were required to submit a firm-fixed price for the initial contract period (1 year) and for each separate option renewal period throughout a ten-year period for whichever

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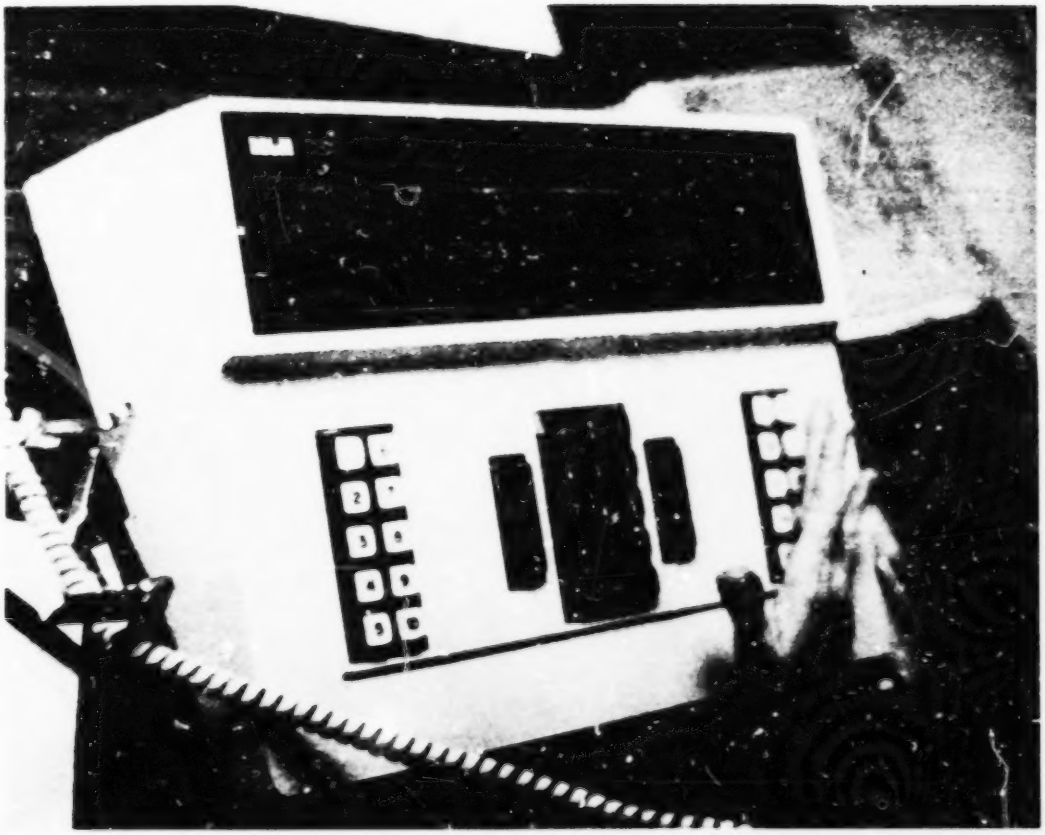
Figure 4. New telephone operators switchboard console.



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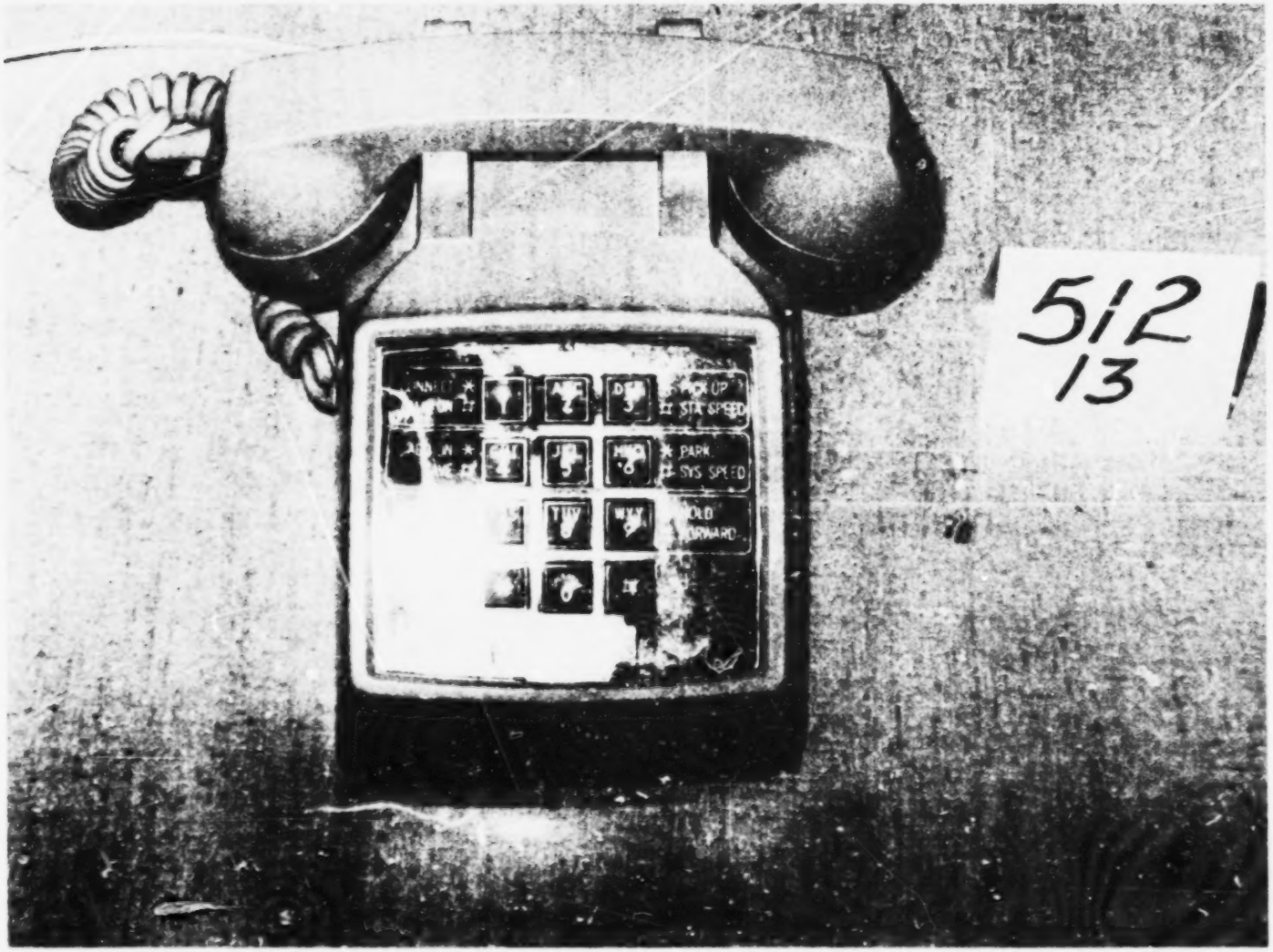

Figure 5. New telephone instrument.

category bid on.

All bids would be evaluated to determine the lowest overall cost, either through purchase, lease, or lease with option to purchase for the entire ten-year economic life of the system.

The bids would be evaluated for award by adding the total price for all ten option periods (after predetermined present value factors are applied) to the total price for the initial contract period including the complete installation cost. The Coast Guard reserved the right not to exercise the options.

In May 1978, after several revisions to the specifications and invitation, the project finally went out for bid. In July 1978 the bids were opened; the JARVIS Corporation of Richmond, Virginia, was the apparent low bidder. On 27 September 1978, the project was awarded to the JARVIS Corporation in the amount of $206,567 for the installation and initial one-year contract period and $8,478 for each year of the ten-year optional renewal period.

Two months later, technicians from JARVIS conducted a survey of the existing RTC telephone system to identify any need for additional equipment. This was necessary because of changes in offices and organization that had occurred at RTC since the original plans and specifications were written in February 1978. The results of the survey indicated that additional equipment was necessary and, therefore, a modification for $40K was issued to the contract.

In December 1978, JARVIS technicians began installing the new system and completed all work on 12 February 1979. As of that date the new system became 95% operational. (Figures 3, 4, and 5 show the new electronic switching equipment, operator's console, and new telephone instrument.)

The project was completed with minimum interruption to the telephone service at RTC, including the critical system cut over, which occurred during weekend hours. It was incumbent on the contractor (JARVIS) to coordinate with the C&P Telephone Company the removal of all C&P telephone equipment from RTC.

Conclusion

With the completion of this project, RTC now has the largest and most modern telephone system in the Coast Guard. Features such as call forwarding, direct incoming FTS station to station calling, busy camp-on signaling and many others are now available with this new system. This system is also the first large scale telephone system that the Coast Guard owns.

Although the final cost of the new JARVIS system far exceeded the original 1977 estimate of $80K, the cost should prove to be far less than that of the original system based upon a ten-year economic payback. At the present time, maintenance of the system is being accomplished by the JARVIS Corporation. However, after the first year, the Coast Guard will have the option of taking over maintenance of the system.

About The Author

LT Bartlett is a January 1972 graduate of OCS at Yorktown, Virginia. Following graduation, he spent three years at the Marine Safety Office, Memphis, Tennessee. In February 1975 he reported to the Engineering Division at the Reserve Training Center, Yorktown, Virginia, where he was a staff design engineer and assistant public works officer. In June 1978 he was transferred to the Civil Engineering Branch, Second Coast Guard District, where he is presently serving as project officer. He holds a Bachelors Degree in Civil Engineering from Newark College of Engineering, Newark, New Jersey, (1971) and a Professional Engineers Registration in the state of Missouri.

It should also be noted that both John Cartwright of the Engineering Division and TT1 Don App of the Public Works Branch at RTC contributed their time and technical expertise in developing this project.

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MARISAT—Another Milestone in Coast Guard Communications

CDR J. A. McIntosh
Electronics Engineering Division
U.S. Coast Guard Headquarters

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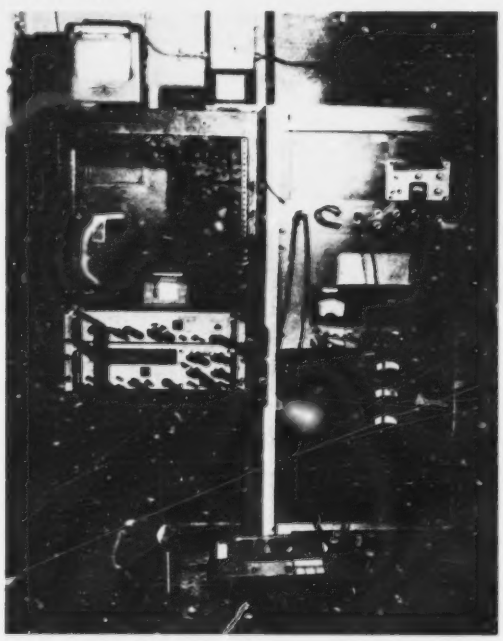
Hardly had SPUTNIK I been launched (on 4 October 1957, in case you forgot) than the potential use of artificial earth satellites for navigation purposes was recognized. The doppler shift of the satellite's radio transmissions made listening to it with a simple receiver cumbersome. Out of this difficulty grew the idea of determining the position of the satellite by measuring the doppler shift. Then it was recognized that if the orbit of the satellite was known, the position of the receiver could be determined. Eventually a satellite was launched expressly for position-finding purposes which, together with the necessary ground equipment, evolved into a system we now refer to as TRANSIT. The Coast Guard has been successfully using TRANSIT on icebreakers and oceanographic ships for many years.

Although it was anticipated early on that satellites would be used for communications, this use did not become significant until satellites were placed into geo-synchronous orbits. Communications via near-earth satellites required antennas that could track relatively fast-moving satellites, which was prohibitive in cost except for the most demanding and critical applications. As satellites in geo-synchronous orbit (particularly the ATS-series) became available, the Coast Guard conducted a number of experiments to examine their capabilities. These experiments, conducted during the period 1968–1972, evaluated voice, data and teletype communications, and examined the feasibility of measuring the ship-to-satellite-to-shore range as an aid in determining the position of the ship. Some of these experiments included ship-to-ship communications, although most were ship-to-shore. The equipment used during this period operated in the VHF band. Typical equipment is shown in Figures 1 and 2. This equipment transmitted an FM signal of about 300 watts output power into a crossed-Yagi antenna having 6 dB of gain. The typical receiver noise figure was 3 dB.

Figure 1. Experimental satellite communications equipment on the CGC *Glacier*.



Although some of the work with the ATS series was almost operational in nature (for example, return of data from the BOMEX oceanographic project from the CGC *Rockaway* during May–August 1969), operational use of satellites for Coast Guard ship-shore communications can reasonably be dated from the installation of satellite fleet broadcast reception equipment aboard WHECs and some WAGBs starting about 1975. However, this equipment was for

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Figure 2. Crossed-Yagi antenna used for CG satellite communications experiments.

shore-to-ship transmission only, whereas the previous equipment permitted transmissions in both directions.

During the period 1975–1977 COMSAT General Corporation orbited three satellites and established appropriate ground facilities to provide semi-automated communications services for commercial ships. COMSAT refers to the satellites and ground stations as the MARISAT system. MARISAT allows ships at sea to communicate with other ships or with shore points via conventional telephone or TELEX circuits.

MARISAT differs from previous satellites used for maritime communications in that it is a complete commercial system, set up for routine use by all suitably equipped ships, rather than a military or experimental satellite available only for short periods or only to certain vessels.

Prior to the establishment of the MARISAT system, several analytical studies were performed to optimize the design, some of which were funded by the Coast Guard. These studies examined the service requirements and the optimum frequency assignments, modulation, signal processing and interference rejection required for a system of this type. These studies indicated that frequencies in the range of 400–500 MHz are technically optimum in that they require minimum power and antenna gain, thus resulting in minimum costs. However, frequencies in this band were not available for MARISAT. Ultimately, the frequency bands of 1535–1543.5 MHz and 1636.1–1645 MHz were obtained for this service.

During the later part of 1978, Headquarters (G-OTM) decided to install MARISAT on several ships to obtain first-hand information on equipment performance and reliability. In addition, experiments with high-speed transmission of messages and with the use of cryptographic equipment on satellite circuits were planned. Further, these installations were expected to provide information on the feasibility of reducing the number of radiomen assigned to a MARISAT-equipped ship and on the benefits to crew morale due to having a high quality telephone circuit available. Finally, experience with operation in very high latitudes (i.e., shipboard antenna elevation angles of zero degrees) was desired.

A MARISAT terminal was installed on the CGC *Glacier* for use during Deep Freeze 79. The equipment operated fairly well and permitted traffic to be passed when all available HF circuits were unusable. Except when the *Glacier* was moored at McMurdo and a large hill was in the "line of sight" to the satellite, operation at high latitudes did not pose any problems. The MARISAT antenna is the large dome mounted above the *Glacier's* bridge in Figure 3. The below-decks equipment is shown in Figure 4.

MARISAT terminals from each of the two domestic manufacturers were installed on the CGC *Taney* and the CGC *Ingham*. Equipment from Magnavox was installed on the *Ingham* and from Scientific-Atlanta on the *Taney*. There are a number of technical differences between the equipment from these sources, one of which is a significant difference in the method of stabilizing the antenna. (Scientific-Atlanta used servo motors to keep the shipboard antenna pointed at the satellite, while Magnavox

used momentum wheels.) The removal of the AN/SPS-29 radars from the 327s provided an excellent location for the MARISAT antennas, as shown in Figures 5 and 6.

Figure 3. View of the CGC *Glacier* showing location of MARISAT equipment.

Figure 5. MARISAT antenna installation on the CGC *Taney*.

The *Taney's* terminal was installed in December 1978 and was removed during September 1979. Its performance was also very good, after having been used on over 300 occasions in locations whose latitudes ranged from Canada to South America. The *Ingham's* terminal was installed during April 1979 and, at this writing, is due to be removed during July 1980. After some initial problems connecting the MARISAT terminal to the ship's gyro, good performance was achieved.

As the present time, our 378 WHECs and 270 WMECs are scheduled to have a U.S. Navy Satellite communications system called NAVMACs A+ installed during the mid-1980's. This system will provide automated, high-speed, cryptographically-protected two-way TTY communications via satellite. Presently the MARISAT satellites are equipped with UHF-band transponders that are used to carry Navy communications in addition to, and separate from, those transponders required for the MARISAT requirements. In the near future the Navy plans to have its own communication satellites, to be known as FLTSATCOMs, aloft.

What future is there in the Coast Guard for MARISAT? Since the 378s and the 270s will be equipped with NAVMACS A+, it would

Figure 6. MARISAT antenna installation on the CGC *Ingham*.

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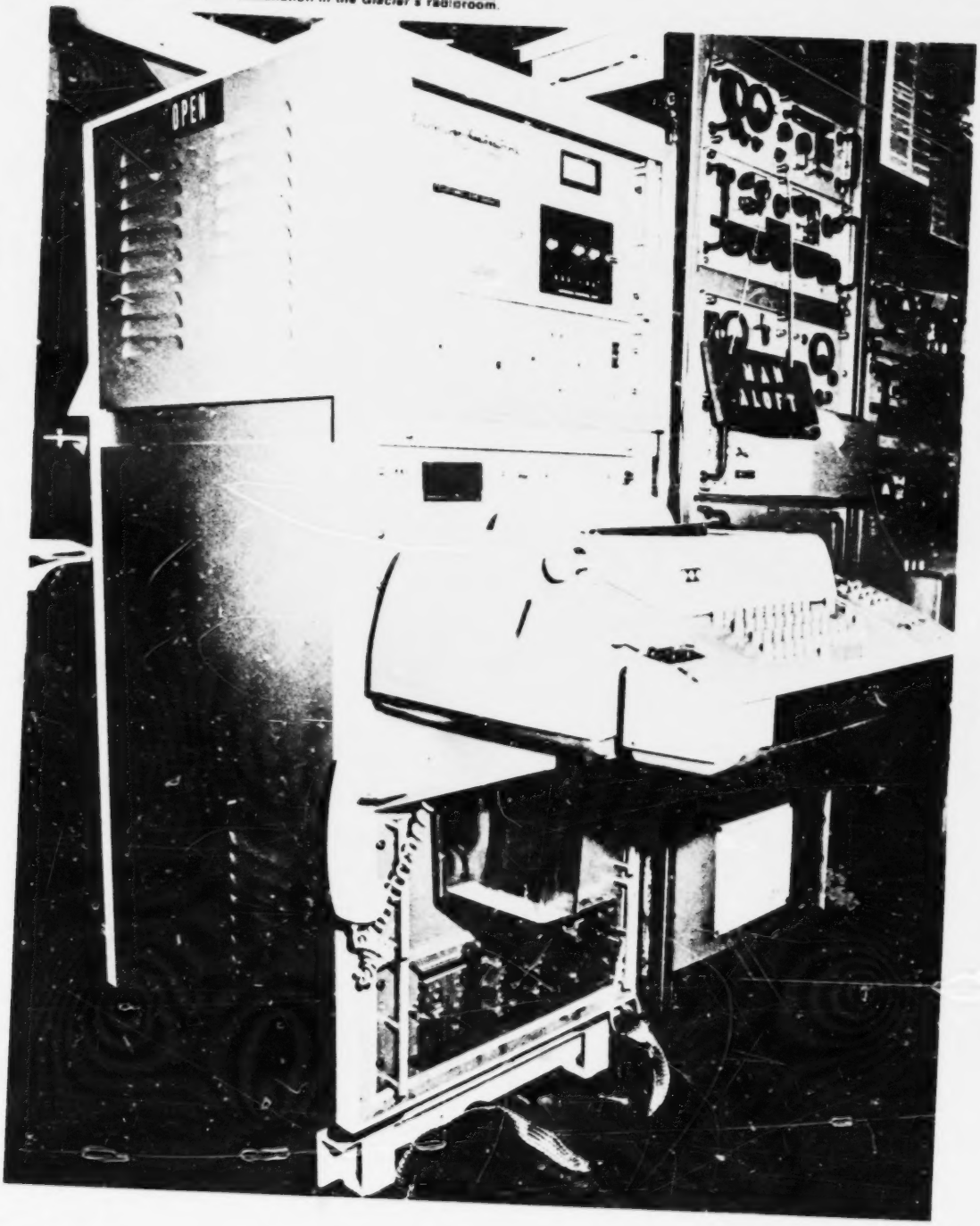
Figure 4 View of MARISAT installation in the *Glacier*'s radioroom.



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be impractical and of limited additional value for them to carry MARISAT also. The 210 WMECs could physically carry MARISAT, although weight and moment limitations would require a substantial reconfiguration of the ship for them to do so. However, the quick and reliable availability of high-quality telephone communications for use during law enforcement cases may make it worth the substantial, additional cost.

MARISAT is particularly attractive for icebreakers participating in Operation Deep Freeze, since the equipment appears to provide far more reliable communications than does HF and yet is completely unclassified. (As a result of a treaty, vessels in Antarctic waters must be completely open for inspection by the other treaty signatories.) However, the number of radiomen carried aboard may well have to be reduced to provide economic compensation for the MARISAT message charges.

The MARISAT system currently has over 230 subscribers, including tankers, freighters, cruise ships, off-shore oil drilling platforms, and a few yachts. International efforts are underway to set up an international organization called INMARISAT, which will operate the satellites that follow MARISAT on behalf of the world maritime community. Thus, if the history of INTELSAT is any guide, maritime satellite communications service is here to stay.

About the Author

CDR McIntosh is a 1962 graduate of the Coast Guard Academy. His assignments have included the CGC *Avoyel*, the CGC *Cape Coral*, the Seventh District Office (eee), Headquarters (G-O) and the Coast Guard R&D Center. He received his postgraduate education at the Air Force Institute of Technology. He is presently stationed at Headquarters and assigned to G-EEE.

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TDL-708: Can We Live With It?

LT W. A. Meiman
Electronics Engineering Division
U.S. Coast Guard Headquarters

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Introduction

To accomplish search and rescue, law enforcement, environmental protection, and other Coast Guard Missions while avoiding marine hazards and expending a minimum amount of fuel, crews of Coast Guard vessels must know their precise positions at all times. An accurate and reliable navigation system such as Loran-C which can be used throughout the Coastal Confluence Zone (CCZ)[1] is an invaluable aid in determining vessel position. With most of our operations occurring in the CCZ, this accurate and reliable navigational aid can be utilized by equipping our vessels with Loran-C receivers. In 1976, the Coast Guard initiated the procurement of TDL-708 Loran-C receivers for installation on all vessels except small boats. However, problems with this receiver delayed deliveries, and it was late in 1979 before the receiver was readily available. Have the problems been resolved to the point that we can live with the TDL-708? This article attempts to answer that question.

Background

Prior to the TDL-708, the AN/SPN-45 was the only phase-tracking Loran-C receiver authorized for use on Coast Guard vessels. At that, these manually operated SPN-45's were only found on WHECs and WAGBs since they were expensive ($22.8K each) and operation of the receiver required a high level of expertise. Early in the 70's, the Coast Guard determined that Loran-C could best satisfy the radio navigation requirements for the CCZ of the United States.[2] However, it was realized that expensive and complicated equipment like the SPN-45 would not be acceptable to our own navigators or to the general user. Therefore, the Coast Guard initiated development of a low cost ($2K) automatic phase-tracking receiver. Clearly, reducing the receiver cost by an order of magnitude required a radical new design. The result was what is known as a hard-limited receiver which was made feasible by the advent of medium scale integrated circuits (MSI). In a hard-limited phase-tracking receiver, the analog RF signal is converted to a digital signal soon after it enters the receiver. Therefore, nearly all of the processing is accomplished digitally. A hard-limited receiver is less complex, less expensive, easy to maintain, and lends itself to automatic operation.

In June 1971, the Coast Guard awarded development contracts for hard-limited Loran-C receivers to the Litcom Division of Litton Industries Inc. and the Teledyne Systems Company.[2] The receivers which resulted, the Litcom LCR-301 and the Teledyne TDL-601, were delivered in June 1972. Subsequent testing on various Coast Guard vessels proved their designs and the feasibility of a low cost Loran-C receiver. April 1974 saw Loran-C selected as the U.S. Government supported radio navigation system for the CCZ; this selection placed greater emphasis on the production of low cost receivers.

TDL-708

In March 1976, the Coast Guard issued a solicitation for a low-cost receiver using a brand name or equal specification referenced to the Decca DL-91 Loran-C receiver. The following June, a contract for 230 TDL-708 receivers was awarded to the Teledyne Systems Company. The contract price for the TDL-708 was $590 per receiver. Subsequent contracts were awarded for 76 additional receivers with the price escalating to a final figure of $2,980 each.

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The TDL-708 Loran-C receiver automatically acquires and tracks signals from a master and two secondary Loran-C stations. Time differences (TD's) are calculated and continuously displayed on two six-digit gas-discharge displays with a microprocessor handling the digital processing within the receiver. Delivery of the first TDL-708's, which later became known as Block I receivers, began in April 1977. Eighty receivers were delivered between then and the following November. The receivers were installed as they became available and no major problems were reported. At this point in the program, Teledyne proposed to make improvements to the receiver in exchange for the Coast Guard allowing a delay in the delivery schedule. The proposed improvements appeared to be beneficial so deliveries were halted for three months beginning November 1977. These improvements included the addition of a display hold switch, a display dimmer switch, an improved test generator circuit, a p.v.c. antenna coupler housing in lieu of the Block I brass housing, and a detachable fiberglass whip antenna in lieu of the Block I integral metal antenna. The "improved" version of the 708, which is shown below, became known as the Block II receiver. Deliveries of the Block II receivers began in January 1978.

Problem

In the summer of 1978, Coast Guard Headquarters and the Electronics Engineering Center (EECEN) in Wildwood, N.J., which maintains the TDL-708, began receiving complaints that the receiver's TD's were sometimes in error by ten microseconds. This was alarming since a ten-microsecond error can translate to position errors of a mile or more in good Loran-C coverage areas. In areas where the Loran line crossing angles are less than optimum, the position error is greater. At first the problem was thought to be receiver misalignment. Investigations verified that some receivers had been misaligned, but the major cause of the TD errors was traced to the new fiberglass whip antenna and coupler. We halted delivery of the TDL-708's in September 1978 after having accepted 100 Block II receivers and consulted with Teledyne about the problem. It turned out that the improved antenna coupler was simply the Block I coupler circuitry repackaged in a p.v.c. housing.

There were no changes to either the circuitry or the tuning procedure. This in itself is not a problem but the improved coupler included the fiberglass whip antenna in lieu of the Block I metal antenna. Investigation revealed that the impedance (capacitive reactance) of the fiberglass antenna is less than the impedance of the metal antenna. Since the antenna served as part of the tuned circuit of the antenna coupler, addition of the new antenna without changing the coupler circuitry and/or tuning procedures resulted in detuned coupler circuits which caused improper cycle selection and the ten-microsecond errors.

Correction

Teledyne modified the circuitry and tuning procedures for the antenna coupler to correct the cycle selection problem. At the same time, they made some additional minor changes in the receiver. Deliveries of the modified Block II receivers began in December 1978. These receivers were designated Block III which meant that the Coast Guard now had three different versions of the TDL-708 Loran-C receiver (Block I, Block II, and Block III). A total of 126 Block III receivers were delivered between December 1978 and June 1979. As a check of alignment after the in-plant

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inspection, a sample of four receivers was selected from each lot of 30 receivers offered for delivery by Teledyne and tested at EECEN. While deliveries of Block III receivers were taking place, all Block II receivers were recalled to Supply Center Brooklyn. Eighty-nine of the 100 Block II receivers were located in the recall. These receivers were forwarded to Teledyne for retrofit to the Block III configuration. Because features in the Block III receivers such as the p.v.c. antenna coupler were desirable for the Block I receiver, all 80 Block I receivers are being partially retrofitted by EECEN when they are returned for repair. Only about half of the 80 Block I receivers have been retrofitted to date.

Present Status

All but 29 of the Block II receivers have been retrofitted by Teledyne, checked out at EECEN, and returned to the field. The 29 remaining Block II units will be repaired and retrofitted by EECEN. The Block I receivers that have been retrofitted have been returned to the field by EECEN. Receivers not located by the recall will be retrofitted by EECEN as they are returned for repair. Retrofitted receivers were distributed on an as needed basis, but with only 20 or 30 receivers becoming available at any one time it was not possible to satisfy all requirements as quickly as desired. This was particularly hard on the East Coast districts since it was necessary to give preference to the West Coast because of the termination of Loran-A. There are now approximately 250 TDL-708 Loran-C receivers in the field and, except for district prepositioned spare receivers, this satisfies 95% of our requirements. Recent reports on the performance of the TDL-708 have been good so there is cautious optimism that the problems have been solved. There is one word of caution. All Block III and retrofitted TDL-708 Loran-C receivers are aligned to operate with the p.v.c. antenna coupler. Operation of the receivers with one of the Block I brass couplers may result in ten microsecond TD errors. This is mentioned only because some of these couplers are still in the field. (P.S. If you know where a missing unretrofitted Block I receiver[3] or coupler (brass) is, please notify Commandant (G-EEE) to arrange for a replacement.)

One remaining problem with the TDL-708 is that it emits electromagnetic interference which interferes with CH 16 on some VHF-FM communications receiver installations. This problem is being investigated. Two modifications, one developed by Teledyne, the other by EECEN, are now under evaluation. The final solution will most likely be implemented with a field change.

Summary

The major problems with the TDL-708 have been solved, its reliability appears to be acceptable and it provides accurate TD information in any area covered by the Loran-C ground wave.

The Future

What about the future? Many new Loran-C receivers have been introduced since the first TDL-708 was produced in 1977. These new receivers benefit from the technological advances that have taken place since the TDL-708 was designed. The most dramatic change has been in the microprocessor. The TDL-708 uses one for most of its processing but it is not nearly as fast nor as powerful as today's micro's. Consequently, the new receivers are faster and offer additional features; they acquire and track up to four secondaries; they have up to four notch filters; they provide guidance information and they have envelope to cycle difference (ECD) and signal-to-noise ratio readouts. These new receivers are being evaluated in preparation for the time when the TDL-708 becomes unserviceable and must be replaced. Even though the TDL-708 lacks some of the conveniences of the newer receivers, it does have the same architecture, and essential capabilities; and it provides the time difference information necessary to meet current operational requirements for safe navigation.

[1] The Coastal Confluence Zone (CCZ) is the area from the coastline out to a distance of 50 nautical miles or to the 100 fathom depth curve whichever is farther from shore.
[2] Hassard, R. W., LCDR USCG, "Low Cost Loran-C Receivers," Coast Guard **Engineers Digest,** JUL-AUG-SEPT 1973 p4.
[3] A retrofitted Block I TDL-708 can be identified by the red "Scotch-Cal" warning label on the top of the receiver. Block I receivers not having this warning label have not been retrofitted.

About The Author

LT Meiman entered the Coast Guard with a Bachelor of Electrical Engineering Degree from the University of Louisville. He graduated from the Coast Guard Officer Candidate School in 1971 and was assigned as a project engineer at the Electronics Engineering Center in Wildwood, NJ. He received a Master of Science in Engineering Degree from the University of Michigan in 1975 and was awarded a Master of Engineering Degree by the University of Louisville in 1976.

LT Meiman served as a project engineer at the Coast Guard Station Alexandria Electrical Engineering Laboratory from 1976 until 1978 when he was assigned as a project manager at CG Headquarters (G-EEE).

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Professionalism and Certification of the Engineering Technician

Mr. John A. Herr, C.E.T.
Cape May, NJ

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As a result of teamwork between Scientists, Engineers, Technicians, and Craftsmen, significant technological advances were made during the early 1950's. Although the Technicians played a major role in this team, there was no universally recognized procedure to provide them with recognition. Because of this deficiency, in 1961 The National Society of Professional Engineers formed the Institute for the Certification of Engineering Technicians (ICET) as a part of their organization's by-laws.

The first task undertaken by this newly formed board, known as ICET, was to define an Engineering Technician. The efforts of that board developed the definition that still remains in use today. This definition reads: "An Engineering Technician is one who, in support of and under the direction of Professional Engineers or Scientists, can carry out in a responsible manner either proven techniques, which are common knowledge among those who are technically expert in a particular technology, or those techniques especially prescribed by professional engineers. Performance as an Engineering Technician requires the application of principles, methods, and techniques appropriate to a field of technology, combined with practical knowledge of the construction, application, properties, operation, and limitations of engineering systems, processes, structures, machinery, devices, or materials, and, as required, related manual crafts, instrumental, mathematical or graphic skills. Under professional direction, an Engineering Technician analyzes and solves technological problems, prepares formal reports on experiments, tests, and other similar projects or carries out functions such as drafting, surveying, technical sales, advising consumers, technical writing, teaching or training. An Engineering Technician need not have an education equivalent in type, scope, and rigor to that required of an engineer; however, one must have a more theoretical education with greater mathematical depth, and experience over a broader field than is required of a skilled craftsman who often works under the Engineering Technicians's supervision."

ICET functions as a certifying body. On a national basis, it examines the qualification of those who voluntarily submit credentials. Appointments of those who serve on the certifying board is made up of four (4) registered Professional Engineers and four (4) Senior Engineering Technicians. Selection of the Engineers is made by the National Society of Professional Engineers. The Technicians are selected by ICET. All applying applicants found qualified by the certifying board are placed in one of three (3) categories: Associate Engineering Technician, Engineering Technician, or Senior Engineering Technician.

The criteria for certification in the three respective grade levels are as follows: those who have earned Baccalaureate or Associate Degrees in Engineering Technology from an accredited Engineer's Council for Professional Development (ECPD) program are eligible for certification without taking the ICET equivalency examination. Those who have educational backgrounds from institutions not approved by ECPD and those who have equivalent work experience may be certified by taking the ICET Technician Qualifying Examination. The degree of education and experience establishes the grade classification. The grade of Senior Engineering Technician is obtained after one has had ten additional years of experience after obtaining the grade level of Engineering Technician. The above

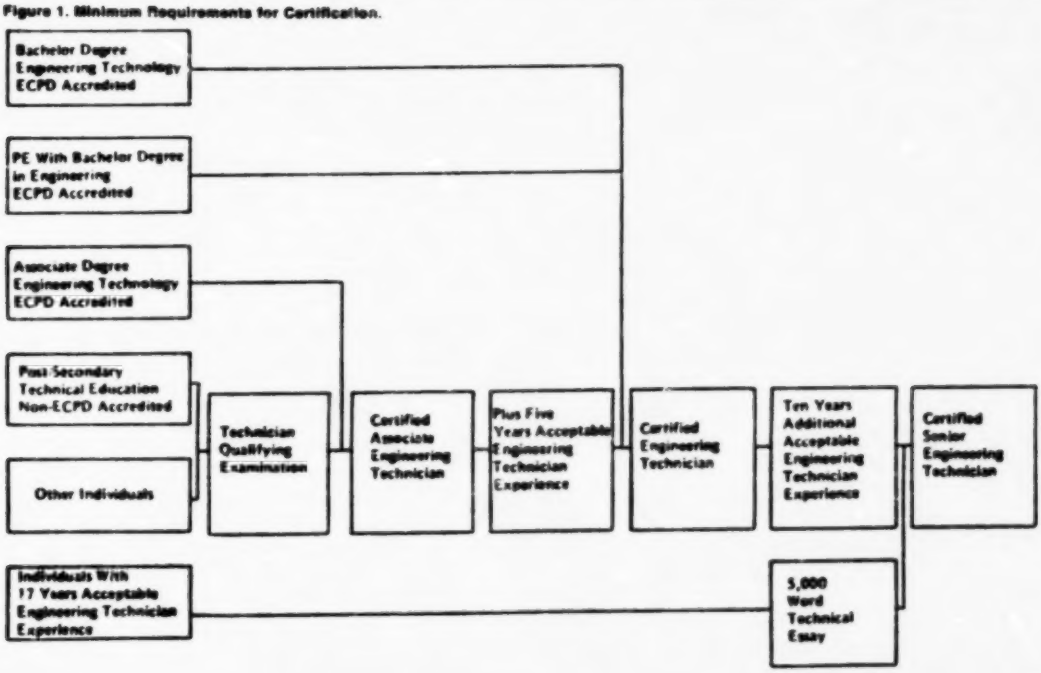
qualification requirements are shown graphically in Figure 1.

Qualification by examination is based on the knowledge that one would normally obtain in an ECPD approved Associate Degree Program. There are two parts to the examination. Part "A," is a general examination given to all applicants. It contains 25 questions in communication, mathematics, and physical science. Part "B," is made up of two sections. The first section is composed of 25 questions on basic technical aspects or one's specific discipline. The second section of 20 questions is so constructed that the applicant may select to answer questions from a number of items on the examination relating to his or her job function.

After obtaining ICET certification one is eligible for membership in one's own professional organization known as the American Society of Certified Engineering Technicians (ASCET). Its goals are as follows:

1. To provide guidance, incentive, and educational opportunity for continuing development and growth in all areas of the Technician's professional life as a CET.
2. To develop methods to improve utilization of the Technician's accomplishments as a CET through cooperative relations with other Engineering Societies.
3. To provide a constant flow of essential information concerning events, people, technology, materials, methods, etc., pertinent to the Engineering Technician Community.
4. To work to assure recognition of CET's as vital, essential members of the Engineer/Scientific/Technician team in service to the nation's and public's welfare.
5. To promote economic, social, and ethical responsibilities of CET's.

Figure 1. Minimum Requirements for Certification.


Bachelor Degree Engineering Technology ECPD Accredited
PE With Bachelor Degree in Engineering ECPD Accredited
Associate Degree Engineering Technology ECPD Accredited
Post-Secondary Technical Education Non-ECPD Accredited
Other Individuals
Technician Qualifying Examination
Certified Associate Engineering Technician
Plus Five Years Acceptable Engineering Technician Experience
Certified Engineering Technician
Ten Years Additional Acceptable Engineering Technician Experience
Certified Senior Engineering Technician
Individuals With 17 Years Acceptable Engineering Technician Experience
5,000 Word Technical Essay

6. To provide a forum in which to voice the concerns of CET's on a national, regional, state, and local basis.

This article describes briefly Engineering Technology Certification. What it can do for you or perhaps your employees, is up to the individual. If you are interested in becoming certified or are interested in certification for your employees, feel free to contact the institute for the Certification of Engineering Technicians, 2029 K Street, N.W., Washington, D.C. 20006.

Commandant's Comments

The Institute for the Certification of Engineering Technicians provides technicians a national society that serves their professional needs and provides recognition of their qualities, attainments, and interests. I strongly recommend that all Coast Guard engineering technicians pursue certification in this national institute.

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Coast Guard Tests New Inflatable Rescue Boat

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The Coast Guard may equip some of their cutters with modern inflatable rescue boats if operational tests and evaluation being conducted on board the CGC *Alert* prove favorable.

The Coast Guard, in conjunction with the Naval Engineering Center, Norfolk, Virginia, installed the Rigid Hull Inflatable Boat (RHI) and Single Point Davit System (SPDS) aboard the CGC *Alert* in November 1979 while the ship was at Coast Guard Yard, Curtis Bay, Maryland.

Preliminary Operational Tests of the RHI and SPDS began in December of 1979, during off-shore Law Enforcement Patrol. Both the RHI and SPDS were operated extensively to determine the capabilities and limitations of the system.

The RHI is the rescue version of the AVON Searider, 5.4 meter, 5 inflatable chamber, fiberglass hull recreational craft manufactured in England and imported by Inland Marine, Wilkes-Barre, Pennsylvania.

The RHI aboard the CGC *Alert* is equipped with a 70 horsepower engine and is capable of speeds of up to 38 knots.

The SPDS, called the Sealift Crane by the builder, Appleton Machine Company, Appleton, Wisconsin, is a revolutionary launch system that requires only one person to operate.

When asked if the RHI could fill the Coast Guard multimission purposes of Search and Rescue, Law Enforcement, and other patrol functions, CDR James F. Coen, Commanding Officer, CGC *Alert* stated, "I was very enthusiastic in having the privilege of the prototype (installed) aboard *Alert*, but I must admit I also was apprehensive about its use for our multimission purposes. Its performance to date has been truly outstanding and I feel it can only become better . . . (as a result of these tests and evaluation)."

The RHI and SPDS have shortened the time required from first command to actual launch to an impressive 9 to 11 minutes. Only two people are required under favorable sea conditions, one to operate the "Sealift Crane" and one to guide the RHI over the side of the ship. The RHI requires only a two person crew and requires no pre-launch inspection or engineer.

Because of the inflatable gunwhales acting as cushions, the RHI is considered to be safer for boardings and coming alongside a disabled craft in heavy weather.

CDR Coen does not predict that the RHI and SPDS will replace the service's 25 foot MSB lifeboats but instead the system will become another tool for the Coast Guard multimission purposes.

The Rime of the Ancient Engineer

Arlan K. Andrews, Sr.

Reprinted, with permission, from *Isaac Asimov's Science Fiction Magazine*, Vol. 4, No. 1 (whole no. 23) January 1980.

Far up on Mount Olympus at the smithy
of the Gods,
Hephaestos, crippled Engineer, picked up
His measuring rods.
He checked and rechecked carefully the
sizes of His mold
Then quickly poured the melt inside and
watched till it was cold.
And when He took the mold apart and
brushed away the sand
He saw two dozen figures there He'd
made by His Own hand:
Two dozen elves, immortals, just as
specified by Zeus.
He'd program them with RNA and then
He'd turn them loose.
Two dozen elves, on schedule, and exactly
as designed—
Technicians skilled in systems, helping new
worlds to unwind.
The nomenclature for the gnomes? "Some
fragrance," Zeus preferred.
Rose water wasn't apropos and so He
called them *Myrrh*.
Myrrh-Alpha was the first one through; He
programmed in its duty:
"I've optimized your circuits for the great
design of Beauty."
Myrrh-Beta He programmed for Love,
Myrrh-Gamma for the Arts
And so on through the alpha-bet each
Myrrh-thing took a part.
But as He neared the final *Myrrhs*, a sound
rang through His shed:
The bell from Aphrodite's room was
triggered by Her bed.
He thundered up Olympus' slopes and
caught Her there with Mars.
The fight They had made planets flip and
supernovaed stars.
The battle reached a standstill and
Hephaestos came back down.
He finished up the last four *Myrrhs*, His
great face in a frown.
So thus from Mount Olympus flew two
dozen *Myrrhs* in all
To aid Mankind and help the Earth. They
had the wherewithal.

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Myrrh-Alpha made the sunset red,
Myrrh-Beta worked out Sex.
Myrrh-Gamma spelled out artists,
Myrrh-Delta, architects.
Myrrh-Epsilon made Medicine,
Myrrh-Zet', Biology;
Myrrh-Eta, culinary arts, *Myrrh-Thet'*,
Theology.
To every craft and pastime a deific *Myrrh* adhered
And everything went smoothly till it came to Engineers.
The *Myrrh* made when the Fight began had stayed too warm too long,
Hephaestos' hate when finishing made other things go wrong.
For *this Myrrh*-thing began to think, and plan and analyze.
Its brethren *Myrrhs* went blindly on, but *this* one got too wise.
"I am," It said, "Therefore, I think. And that's a hellish note.
I'll formulate and specify." And this is what He wrote:
"No blindly-driven robot, I, though Gods Themselves may panic.
I'll institute impedance here and that's *thermodynamics*.
Rule One: (I say, it must be so) What comes out, must go in.
Rule Two: You always lose a bit, no way to ever win.
And then I opt for Entropy so everything runs down.
You'll have to work to keep things up, or elsewise you'll lose ground.
To maximize this well-run Earth and keep my good relations
I'll give Mankind a little hint: look for 'max-well' equations."
So on and on the Chaos came; a veritable fount
Until the other *Myrrh*-things called Hephaestos from the Mount.
Hephaestos, that sad crippled giant, He signed at what He saw,
But said, "There's not a warranty, although I note the flaw.
I do not like this Thermo thing nor other Laws I see.
And Man will curse this *Myrrh*-thing to the end of Eternity.
But the race of Man and you other *Myrrhs* must pay the price because
Of the Patron *Myrrh* of the Engineers: you're stuck with *Myrrh-Phi*'s Laws!"

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U.S. DEPARTMENT OF TRANSPORTATION

The Coast Guard Engineer's Digest

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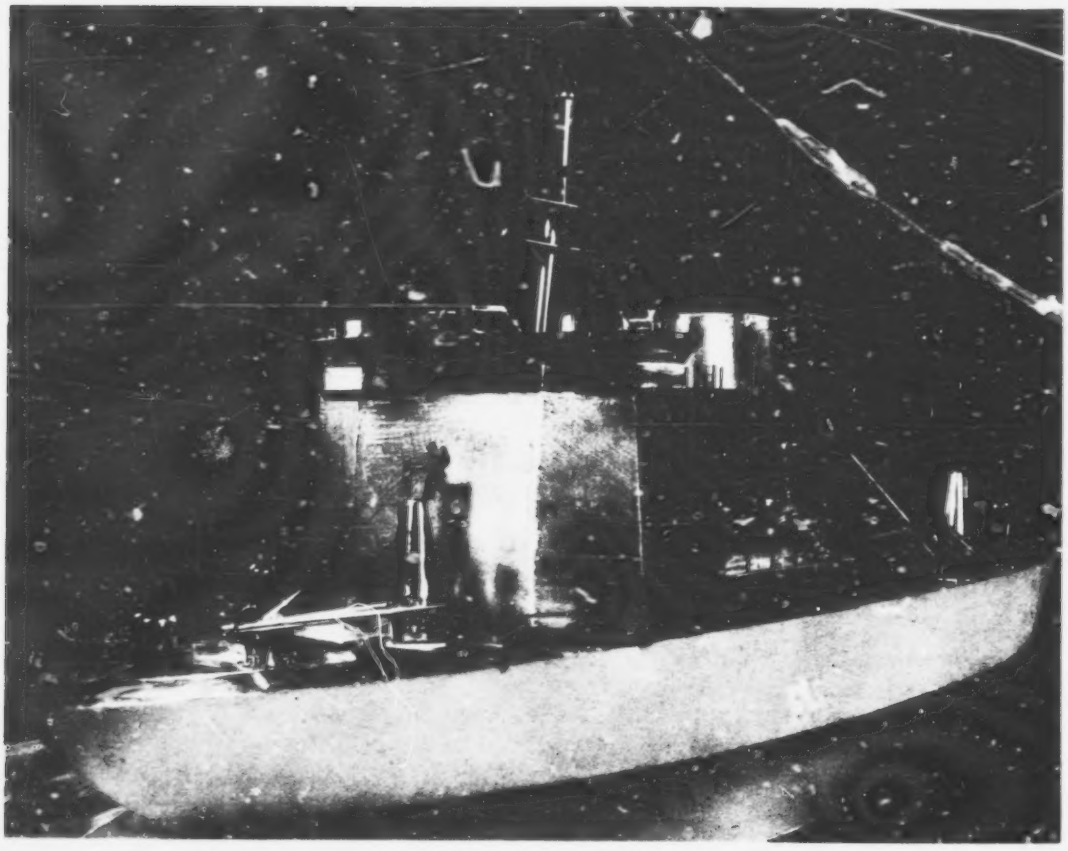

CG 133
Volume 20

Number 208
Fall 1980

The Coast Guard **Engineer's Digest**

United States
Department of Transportation
CG-133

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The Coast Guard **Engineer's Digest** is an official publication of the Office of Engineering, U.S. Coast Guard Headquarters, Washington, D.C. Now published quarterly, the **Digest** has been a medium for communicating new ideas and technology of interest to Coast Guard engineers since April 1933.

The **Digest** is a professional journal for the publication of research papers, special studies and general interest articles aimed at advancing engineering in the Coast Guard.

While some material for the **Digest** is reprinted from other technical publications, most papers are submitted from the field by Coast Guard engineers and engineering managers, both military and civilian.

The Office of Engineering encourages all Cost Guard personnel in engineering-related fields to share their ideas and experiences, successes and failures, with the Coast Guard engineering community by submitting articles and papers for publication in the **Digest.**

Observe the following guidelines when submitting material for publication:

- Manuscripts should be typed double spaced on one side of 8 × 10½ or 8½ × 11-inch white paper, leaving at least a 1-inch margin on all sides.
- Original articles by Coast Guard personnel (civilian and military) should have a byline, giving name, title, and unit, and a short biography of the author.
- Illustrations—glossy black and white photographs or line drawings—should be approximately 8 × 10 inches in size. In cases where the author does not have adequate facilities for producing finished art, the **Digest** can have artwork made up from the sketches.
- Complete figure captions and figure numbers should be listed on a separate sheet of paper or taped to the back of each illustration. Do not use staples or paper clips on photographs. Protect illustrations for mailing by placing them between pieces of stiff cardboard.

Send articles, letters, photographs, suggestions, etc., to:

Editor, **Engineer's Digest**
U.S. Coast Guard Headquarters (G-Eg/TP62)
Washington, D.C. 20593

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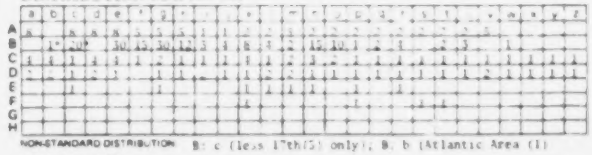

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History of the Oren Medal and Cowart Plaque

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Each year the Society of American Military Engineers (S.A.M.E.) presents an award to one individual and to one unit in the Coast Guard. The Oren Medal, named for Rear Admiral John B. Oren, USCG(Ret.), is awarded to the individual who has been outstanding in civil engineering. The Cowart Plaque, named for Vice Admiral Kenneth K. Cowart, USCG(Ret.), is awarded to the outstanding civil engineering organizational unit. A special plaque outside the Civil Engineering Division at Headquarters is engraved with all the recipients of these awards since their inception twelve years ago.

The awards began in 1967 when Admiral Oren, then Chief of the Office of Engineering noted that no such recognition existed for Coast Guard engineers, though S.A.M.E. awards for the other military services had been established for some time. Admiral Oren sent a memorandum to the Commandant which said in part:

> "I have been concerned for some time with our failure to properly recognize our engineers, both military and civilian, for their outstanding achievements . . . .
>
> . . . The Society of American Military Engineers administers a program that awards medals and Certificates of Merit annually to engineers who have brought distinction to themselves and their parent organization. Unfortunately, the sponsors of many of the awards limit the recognition to a specific service. For example: The Peltier Award is given only to a construction battalion of the Regular Navy. The Newman Award is only for members of the Air Force Civil Engineers. The Coast Guard sponsors no similar awards. . . .
>
> . . . Recognition of our engineers by the professional community will instill in our personnel a feeling of pride and a sense of belonging if they know that their efforts will not go unnoticed. It is therefore recommended that the Coast Guard seek a sponsor for an award. . . ."

The Commandant, Admiral Smith, was amiable to the suggestion for an award to Coast Guard Civil Engineering personnel. However, a sponsor was needed to pay the costs of several years supply of the award. In addition, what would the Coast Guard name the award? (S.A.M.E. awards are traditionally named after distinguished military engineers who had been Presidents of the Society and also Chiefs or Directors of Engineering for their respective services.)

A civilian engineer named Howard Wickes heard about the plans for this Coast Guard tribute to its engineers and volunteered to sponsor the award. Mr. Wickes had recently retired from his post as Chief of the Structural Section of the Twelfth District, Civil Engineering Branch. He had worked with Admiral Oren when the Admiral was a Captain and Chief, Engineering Division in the 12th District. Howard Wickes was familiar with the Admiral's dedication to the Coast Guard and he and several prominent Coast Guard personnel suggested that the award be called the Oren Medal. A generous man, Mr. Wickes was also anxious to sponsor a second award, to be given to an outstanding organizational unit since ". . . an outstanding achievement by an individual is rarely a result of his own work entirely."

Rear Admiral Kenneth K. Cowart (Ret.) was the unanimous choice to name this group award after. Admiral Cowart, in his letter accepting this honor, called the awards ". . . an important milestone in Coast Guard engineering."

Most Coast Guard civil engineers are aware

that these two awards are in existence. However, few know the interesting backgrounds of the three men whose names are associated with them:

Howard Wickes, sponsor of the awards, is a remarkable man. A civilian retiree, Wickes started his career with the Coast Guard at the unusual age of 69. In his earlier years, he had owned an engineering firm. Upon "retirement" at 65, he worked for a while as a consulting engineer and then at 69, decided that he had something more to contribute. The Coast Guard agreed and hired him. Several years later, when he reached the mandatory retirement age of 72, there were many protests from high places and he was asked to stay on, earning a reputation as an outstanding Chief of the Structural Section of the Twelfth District. At the age of 77, he finally did retire from his late-in-life successful second career. Reached at home and interviewed for this article, Mr. Wickes volunteered his age (88), his golf score (86), his health (hale and hearty), and expressed his continued interest in, and sponsorship of the Oren Medal/Cowart Plaque.

Rear Admiral Oren's distinquished career included sea action in World War II. He was assigned Executive Officer on board the Cutter *Spencer* during the war, and saw action in three gruelling battles with enemy submarines. In one of these engagements, the *Spencer* sank the Nazi submarine U-225. Another battle was the *Spencer's* memorable attack and sinking of the U-179 during which forty prisoners were captured.

In August 1943, he was assigned to the outfitting detail on the new heavy duty icebreaker *Westwind* which was being built at San Pedro, California, and became her Engineer Officer when she was commissioned the following year. In 1945, he was instrumental in the Lend Lease Program for delivering the *Westwind* and a sister icebreaker to the U.S.S.R.

Admiral Oren was appointed to the rank of Rear Admiral in June 1964 and assigned as Chief, Office of Engineering at Headquarters until his retirement in January 1966 with more than 34 years of service. He was awarded the LEGION OF MERIT for this last tour of duty.

Admiral Oren's World War II campaign service ribbon and medal decorations included the following: American Defense, American Area, European-African-Middle Eastern Area (3 battle stars), Asiatic-Pacific Area, and World War II Victory.

Admiral Cowart retired in July 1959 with more than thirty years of service including sea action in World War II. In December 1942, he became Engineer Officer of the combat Cutter *Campbell*. While on convoy escort operations, the cutter rammed and sank an enemy submarine with gunfire and depth charges, and took several of the crew as prisoners. (During the twenty-four hours prior to ramming the submarine, the ship had engaged five other U-boats.) During the battle, the cutter took a large tear in her side plating leading to the engine room. Admiral Cowart directed the damage control measures to check the rising water, and was instrumental in getting the cutter safely towed to port. For his gallantry and tireless efforts, Admiral Cowart was awarded the SILVER STAR.

The Admiral received the NAVY COMMENDATION RIBBON for outstanding performance of his next tour of duty as Chief of the Merchant Marine Personnel Division at Headquarters.

From September 1945 to April 1946, he commanded the troop transport *USS Admiral E.W. Eberle* (AP-123) in the Pacific. While under his command, that transport set a record of 8 days, 7-3/4 hours for Pacific transport crossing while returning troops from Nagoya, Japan, to Seattle, Washington.

In August 1950, he was appointed by President Truman to a four-year term as Engineer-in-Chief of the Coast Guard with the rank of Rear Admiral. He was reappointed by President Eisenhower for a second four-year term in 1954. He was the last officer to hold the title of Engineer-in-Chief; since 1954 the title has been Chief, Office of Engineering. He then served as special assistant to the

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Commandant until he retired.

In addition to the SILVER STAR and NAVY COMMENDATION RIBBON, Admiral Cowart has the following World War II campaign service medals and ribbons: American Defense, American Area, European-African-Middle Eastern Area, Asiatic-Pacific, and World War II Victory.

Finally, this history would not be complete without recognition of the winners of these awards. There has been no shortage of exceptional people and units to bestow these honors upon. Every year the list of nominees for each award is ample. Here are the final winners from 1968 to the present:

	OREN MEDAL	COWART PLAQUE
1968	Glen E. Logan (12th)	3rd
1969	Joe Muck (Hdqts)	11th
1970	Gerald O'Hara (9th)	12th
1971	LCDR Karl Reichelt (5th)	8th
1972	Byron J. Clark (13th)	Academy
1973	Robert Stafford (13th)	17th
1974	CDR Walt Peterson (Hdqts)	7th
1975	CDR John R. Wells, Jr. (7th)	5th
1976	Hisashi Imanaka (14th)	Activities Europe
1977	Raquel McAllister (12th)	8th
1978	Dr. Robert G. Boggs (Academy)	1st
1979	Martin J. Boivin (13th)	5th

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Air Station Traverse City New Hangar Facility

LT Lesko
Civil Engineering Branch
Ninth Coast Guard District

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The Ninth Coast Guard District has completed a 3.8 million dollar hangar facility located at Coast Guard Air Station Traverse City, Michigan. Utilizing AC&I funds, the construction contract was awarded to an 8A Joint Venture Contractor based in Michigan and Indiana for $3,755,798 and work was begun in mid-August 1978. The contract was successfully completed in seventeen months with no significant delays or complications.

Design criteria called for a facility to hangar three fixed wing aircraft (Falcon 20G jets) and two rotary wing aircraft (HH-52's) plus the entire support/maintenance shops and administration offices. During the initial design phase many schemes were considered and a system of assigning values or "weights" to the various desired characteristics had to be used to make a comparative analysis of the alternate plan arrangements. The most satisfactory design consisted of a 300 foot x 125 foot structure encompassing a 300 foot x 85 foot hangar deck with cantilever structural framing with 24 foot clearance. In addition, a 300 foot x 40 foot two-story shop and administration area is located along the rear wall. Aircraft access to the hangar deck is through eight independently powered, multiple leaf, horizontal sliding doors which ride on a four-rail system which is heated to prevent ice jamming.

Included in the design are provisions for expandability, maintainability, and initial cost reduction. Expansion of the cantilevered structures is exceptionally simplified since any new addition would be structurally independent of the initial hangar. Interior expansion can be easily programmed in modules because the hangar is designed without interior columns. Maintainability of the facility is considered to be good due to the centralization of the mechanical equipment and the electrical closets, as well as the use of durable and readily available building components throughout the structure. A variety of paint and coating systems such as galvanizing, aluminizing, and conventionally baked enamel were utilized wherever possible to reduce ongoing routine maintenance. Finally, the selection of structural design was determined by its relatively low initial cost when compared to other design schemes. The simplified arrangement of the structure for shop and office spaces with relation to the hangar deck and the minimal exiting and circulation requirements made a significant contribution to its cost effectiveness. However, the large hangar doors which are required to provide immediate, unobstructed access to all aircraft bays was a necessary, but costly design penalty. Fire protection for the hangar area is provided by an automatic alarm and ceiling mounted foam deluge system. The entire system including diesel-driven pumps, electrical control panels, and foam reservoirs is located in a completely separate structure adjacent to the hangar. To accommodate the removal of the deluge foam, as well as normal aircraft wash water, an independent water retention basin had to be constructed.

In the event of fire the water runoff cannot be allowed to spread across the hangar deck or apron since the floating combustibles would endanger other equipment and aircraft. To correct this problem the final design includes a hangar deck collection system which pipes the runoff to a sand retention basin away from the hangar where normal evaporation and absorption will occur.

The completed project emphasizes that close cooperation among Headquarters and District level engineering staff personnel,

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Figure 1. Excavation and setup of foundation formwork.

Figure 2. Placement of concrete slab.

Figure 3. Construction of masonry walls and roof framework.

Figure 4. Installation of roof deck.

Figure 5. Metal wall sheathing.

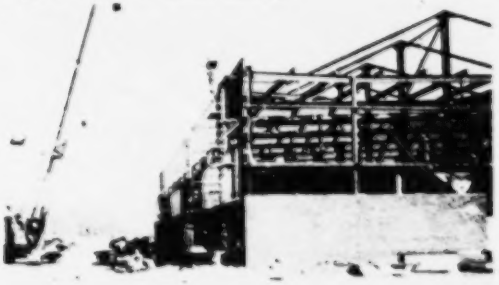

Figure 6. Completed hangar.

the field unit, and the architect/engineer is absolutely essential to arrive at a design that will meet the field requirements and yet not be cost prohibitive. The utilization of A/E services to the fullest extent to develop the facility can be very beneficial and well worth the investment; however, the Coast Guard must closely monitor the planning effort to keep it on the right track and to assure that the finished product is what is asked for and what is really needed.

The successful completion of this project can be attributed directly to the efforts of LT Martin EGER and LCDR Larry KIDD. LT EGER, who at that time was assigned to CCGDNINE (ecv) was designated as the Project Officer. He was responsible for the architect/engineer selection procedures and the close cooperation between the A/E and District Engineering Office during the design phase of the project.

This involved administering all contract submittals, work schedules, modifications, partial payments, and other pertinent administrative tasks during the performance of the contract.

LCDR KIDD, a Coast Guard aviator assigned to Coast Guard Air Station Traverse City, was designated as the Government Construction Representative for the contract. While fulfilling his flying duties, LCDR KIDD also provided nearly full time inspection of the construction work and was directly responsible for assuring that high quality workmanship was maintained throughout the contract. In addition, he acted as liaison between the contractor and LT EGER. Without the devoted efforts of both individuals, the timely completion of the well-engineered and constructed hangar could not have been possible.

About the Author

The author is a 1973 graduate of the New Mexico State University B.S. Civil Engineering Technology Program. Previous assignments have been in CCGDONE (ecv) and CCGDTHREE (ecv) and tours of duty with the U.S. Army and Navy Reserve. LT Lesko is currently assigned to CCGDNINE (ecv) as Chief, Construction Inspection Section.

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Figure 7. Interior view.

Main Reduction Gear Inspection at Ten Year Interval

LCDR J. G. Soland, USCGR
Support Group Seattle
Thirteenth Coast Guard District

Mr. Gustav Liljegren
Gear Consultant
Bellevue, Washington

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The intent of this article is to furnish the reader with a general guide for a Main Reduction Gear Inspection and Overhaul. Although the article specifically details two major overhauls on HAMILTON Class Cutters (i.e. CGC *Boutwell* AND CGC *Munro*), it contains pertinent inspection and overhaul information for many types of main reduction gears and most propeller shafting arrangements.

A basic inspection requirement was generated when the Commandant directed all Districts with 378's to conduct an inspection of the Main Reduction Gear Lubrication System in 1978. During the previous year several 378's had experienced failure of the following reduction gear bearings:

Bull Gear (Forward)
Intermediate Shaft (Aft)
Diesel Quill Shaft (Aft)
Gas Turbine Quill Shaft (Forward)

It was suspected that the bearing failures might be associated with the long history of attached lube oil pump failures occurring at high RPM which allowed the gear to drop, momentarily wiping part of the bearing as the lubricating film was lost.

Since the CGC *Boutwell* was over 10 years old the Thirteenth District performed a 10-year overhaul as detailed in NAVSEA Chapter 9420 in addition to the inspection requirements issued by G-ENE.

Boutwell's inspection was done during the AA/DD in 1978. Unsatisfactory components found on *Boutwell* led to a subsequent 10-year inspection on CGC *Munro*. The results of both inspections are included.

The Article is broken down into the following segments:

A. Inspection Procedure
B. Inspection Preparation
C. Line Shaft Weighing
D. Tooth Contact Wear Patterns
E. Red Gear Bearings
F. Main Thrust Bearings
G. Turbine to Gear Alignment
H. Turbine Dental Coupling
I. Diesel Alignment
J. "SSS" Clutches
K. Lubrication
L. Suggestions, Inspection
M. Suggestions, General
N. Outline of Problems Found
O. Summary

Inspection Procedure

1. Inspect tooth contact wear patterns early in the program to identify any possible bearing and/or alignment problems since tooth contact wear patterns provide key clues to the general "health" of this type of gear unit.

2. Open all babbitted bearings in the reduction gears and the line shafts. Look for abnormal wear or damage. Look for signs of vibration, misalignment, damage and poor workmanship. Make a sketch of each bearing wear pattern and record "crown" thickness. Also photograph the patterns in the babbitt bores. Repair or replace bearings as required.

3. Measure the line shaft bearing loads by the calibrated jack method.

4. Check the alignment of both turbines and diesels to the gears and correct if necessary.

5. Inspect the "SSS" clutches (724 Class only).

6. Make tooth surface tapes for Machinery History.

7. Apply RED DYKEM lacquer coating to bands of teeth for tooth contact checks in the future.

8. Clean the lube oil system, including the gear sumps and pipes which had to be removed during the inspection. Clean and re-fill the line shaft bearings.

Inspection Preparation

1. Apply a thin and uniform coating of RED DYKEM lacquer to a band of teeth on each gear and pinion (except the intermediate pinion which can not be reached) prior to the last operation at sea with each turbine and diesel before tying up for inspection. This will allow checking the current "under load" tooth contacts which sometimes are different from the cumulative wear pattern.

   It is important to clean the bands of teeth completely free of oil before applying the RED DYKEM. Use trichloroethane or equivalent solvent. Type cleaner in spray cans is a convenient source. The RED DYKEM is manufactured by Dykem Co., 8501 E Delport Drive, St. Louis, MO 63114.

2. Clean thoroughly around and above all gear casing inspection covers. Use a piece of brazing rod to loosen the dirt which usually is trapped between the top hinges and the covers and then blow out with an air hose. Emphasize the absolute importance of keeping ALL FOREIGN PARTICLES out of the gear casing. These main gears have an oil pan close under the bull gear and it has NO ACCESS OPENING at the bottom to allow removing lost items.

3. Provide a roll of clear polyethylene plastic sheeting (.006" thickness preferred) for protecting any and all openings in the gear casing. Fasten it with gray or green "duct" tape around the openings. The same tape can be used to cover all pipe flanges as piping is removed.

4. Provide at least one good dial indicator such as the Starrett #25-141 and a substantial magnetic base (Starrett #657-D).

5. Provide one 50-ton hydraulic jack and pump plus a 5000 psi pressure gage. The latter shall be connected between the pump and the jack to give pressure readings during the weighing of the line shaft bearing reactions. The jack and gage should be calibrated by a testing laboratory with a tensile testing machine. Data needs to be taken with increasing *and slowly decreasing* increments of pressure. The jack selected was found to have an actual effective cylinder area of 10.84 sq. inches. That means a pressure of 1000 psi. produces a force of 10,840 lbs. See Figure 10 for a typical calibration curve.

6. Two 3-ton chain falls and several 1-ton and 2-ton "come-alongs" are essential.

7. Provide one 17½-ton hydraulic push/pull jack such as the "Power Twin Rams" Set #Y-18 manufactured by Owatonna Tool Co., Owatonna, Minnesota 55060.

8. Provide one ¾-inch wire rope sling about 12 feet long.

9. Provide a variety of smaller wire rope slings for miscellaneous lifts.

10. Proper eye bolts are important for safe lifting of bearing caps, bearings, thrust spacers, etc.

11. Install a support bracket for the 50-ton jack under each line shaft just forward of the line shaft bearing (#3). It must be able to handle at least 20,000 lbs. and be parallel to the axis of the shaft.

12. A special tool called a "transport clamp ring" is necessary to remove the "SSS" clutch for inspection (724 Class only).

13. Provide a 300 lb. spring scale graduated

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in 8 oz. increments for turbine alignment checks.

14. Make a "V" support for the 8" diameter turbine coupling shaft to be used with the above spring scale.

15. Have available all the special lifting tools originally furnished by Western Gear for raising each gear or pinion rotor enough to allow rolling out the bearing halves.

16. Keep track of all small bolts and special parts in "Zip-Loc" type plastic bags. See item 2 above.

Line Shaft Weighing

The ideal method for measuring the load of the line shaft at each bearing (inside the hull) is to lift the shaft as close as possible to each bearing with a suitable calibrated hydraulic jack. If available, a load cell can give more accurate data. Measure the lift of the shaft directly above where the jack is placed. Use a good dial indicator. Also, set up a second indicator on the side of the shaft to show any lateral movement during the lifting. Remove all rough paint where the indicator contacts the shaft. Athwartships misalignment is often overlooked. It is frequently the cause for 2nd reduction tooth contact problems. Bearing #'s 1 thru 3 are the forward bull gear, aft bull gear, and line shaft bearing, respectively.

Record the hydraulic pressure in the jack as the shaft is raised in 0.001" increments up to the limit of the bearing clearance or the meshing of the gear teeth. It is usually preferable to lift the bearing cap of the #2 and #3 bearings to give a longer curve on the graph paper for more accuracy. Note that the jacking up and the lowering curves are separated. This is quite normal and is due to friction. We weighed both #2 and #3 bearings before going into the drydock. See Figures 1 and 2 for the actual line shaft weighing graphs from *Munro*.

NOTE: The original installation "SHAFTING CALCULATIONS AND ALIGNMENT PROCEDURE" in Plan #724 WHEC-4301-3, Rev. 3 furnished a lot of information.

Figure 1. Line shaft weighing, #3 bearing.

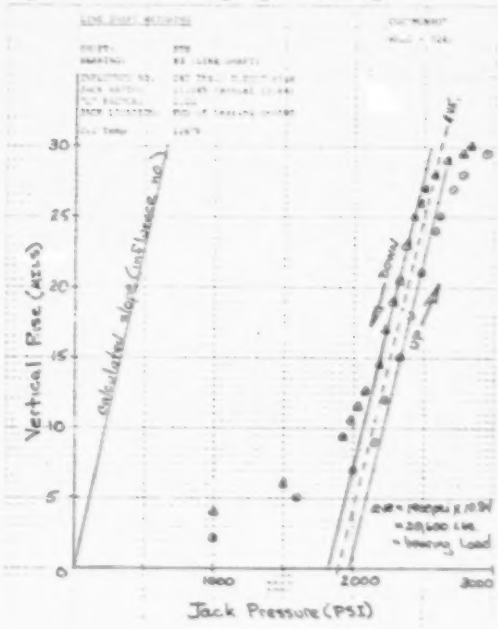
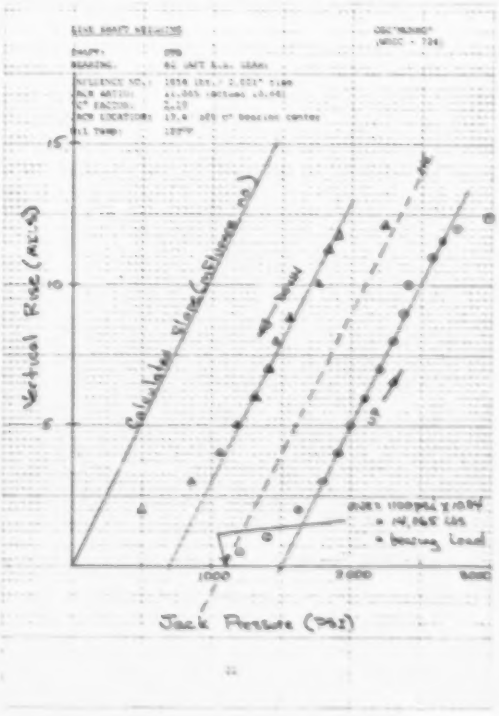


Figure 2. Line shaft weighing, #2 bearing.



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The following was noted on:

CGC *Boutwell*—The #3 bearings were in good condition and somewhat heavily loaded. The #2 bearings were too heavily loaded when corrected for the ambient temperature of 65°F. We suspected that the thrust bearing was causing some extra friction since we were not able at that time to push the line shaft forward to free the Aft thrust shoes.

CGC *Munro*—The Port Aft bull gear bearing load (#2) was very good and the Starboard was slightly heavy. The load on the two line shaft bearings were satisfactory.

BEARING #1—		#1	#2	#3	TOTAL LBS
Bearing load, "hot", design		14145	14145	18527	46817
Bearing load, June, 1971: @ 147°F oil temp.	PORT	15308	16215	16400	47923
	STB	10773	17250	19900	47923
Bearing load, Sept. 1971: @ 82°F ambient (cold)	PORT	20697	7590	20520	48807
Bearing load, Sept. 1978: @ 120°F oil temp	PORT	17845**	11510	18645	48000*
	STB	13335**	14065	20600	48000*

* Estimated
** Calculated, based on estimated total load

Sideways (athwartship) alignment is often overlooked and can affect the bull gear tooth contacts. We found that both shafts moved outboard when jacked up at the line shaft bearings.

Port—0.016" Starboard—0.011"

The 0.016" value is large but no distress was found in any of the Port shaft bearings. There was very little side movement of the shaft when jacking at the Aft bull gear bearings. That is why the tooth contact was not disturbed.

After drydocking and removal of the variable pitch propeller control box at the Forward end, the bearing caps of the thrust housing and #1 bearing were removed on *Boutwell*. The builders method of bolting on a bracket at the Forward end of the low speed shaft was not convenient because of interferring work. So, we arranged a sling set-up to lift the shaft just Forward of the #1 bearing. This method worked very well and had the advantage of requiring a much smaller correction factor.

No attempt was made to weigh the load on the Forward bull gear bearings (#1) on *Munro* because it required major disassembly and that would have interferred with the other work in the Yard. However, knowing the load on two bearings (#2 and #3), it is possible to estimate the load on the third (#1 bearing) because the total load does not change drastically with changes in individual sharing of the load.

The results were satisfactory and were verified by the excellent condition of the bearings and of the bull gear tooth contacts.

After drydocking we rechecked the #2 and #3 bearing loads.

Tooth Contact Wear Pattern

Normal tooth contact aims for uniform sharing of the load on both helices. This usually produces good polishing with no hard contacts which can lead to pitting.

All gears and pinions showed excellent contacts as verified by the RED DYKEM

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lacquer coating and the fact that the fine shaving cutter marks had not yet worn off after so many years.

Only the Port intermediate gear on *Munro* had some small pits in the Aft end of the Forward helix. They are no longer active, having relieved the hard contacts from original manufacturing deviations. The extensive use of the diesel mode also helped to heal the pitting.

Tooth surface tapes were made of each gear and pinion (except the intermediate pinion which cannot be reached). They recorded in fine detail and full size the present condition of the load side of the teeth. Such tapes are particularly valuable to watch the progress of active pitting and to keep track of any "dirt tracks."

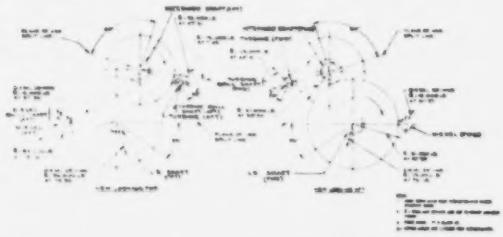
Red Gear Bearings

The most time consuming operation was the inspection of the main reduction gear bearings. Many of *Boutwell*'s had smeared areas of babbitt which at first glance meant replacement. Actually, only one journal bearing (the Aft turbine pinion bearing) and the two Aft steady bearings for the quill shaft had to be replaced. The other smeared bearings were in excellent condition in the loaded halves. Most of the babbitt bearings on *Munro* were as good as new.

The journal bearings did show the effect of the windmilling operations. When operating in the diesel mode, the turbine pinion and gear are down in their bearings and directly across the oil spreader grooves, rather than acting at the bearing reaction point shown on the "Bearing Reaction Diagram" (Figure #3).

All of the oil spreader grooves were defective, having a sharp edge at the tangential blend into the babbitt bore. This created very poor lubrication in several bearings while windmilling. Such a sharp edge acts as a scraper to remove much of the oil film instead of establishing a good oil wedge. We had to blend the spreader grooves tangentially into the babbitt bores.

Figure 3. Bearing reaction and loading diagram, starboard.



This design deficiency should be corrected on other vessels in this Class. In all other respects these bearing (stamped "PNB") were of unusually good quality. They were manufactured by Pioneer Motor Bearing Co. of 116 Beacon Street, South San Francisco, California. In fact, it was generally possible to replace one-half of any bearing without concern for matching the other half. This reduces the spare inventory requirements.

The one disadvantage of this interchangeable design is that it is possible to install the bearings at the wrong angle unless great care is used to follow the BEARING REACTION drawings. (See Figure 3.) Too many lock slots are available to choose from.

Another built-in booby trap for re-assembly is the location of the drilled hole in each bearing cap which feeds the sight-flow glass (bubbler). Every bearing has a bubbler groove in the O.D. near one edge. All are installed (with one exception) so that the grooves are away from the rotors. The same edge has holes for the special spanner wrench pins. The exception can be seen in the cross-section of the turbine pinion axis. The Starboard assembly shows the Forward pinion bearing installed with the bubbler groove and the spanner wrench holes facing the pinion while the Aft bearing is installed like all others. The Port turbine pinion Aft bearing has the same reverse orientation. This is the only bearing and is also equipped with a very special lock slot key as compared with the normal round thick washer type used elsewhere.

Bearing crown (wall) thicknesses were

measured in six locations of the loaded half bearing and in two of the unloaded half. Drawing instructions specify these locations. See CG Dwg 724 WHEC-4200-52 sheet #12. The measuring point of 1¼" in from the edge of the bearing is not possible on the bubbler groove side. All but two bearings had the original crown thickness marked on the end faces. These measurements appeared to have been made with a ball anvil on the micrometer which produced readings as much as 0.002" smaller than those now measured with a 0.025" diameter dowel in the babbitt bore. So, after cleaning up each bearing and blending the spreader grooves carefully by hand scraping, we re-scribed and re-marked each correctly.

Three out of four 2nd reduction gear bearings showed only partial contact along the length of each. This seems to indicate that those casing bores were tilted slightly such as can be caused by improper chocking at the original installation. None required replacement. The fourth bearing (Aft Starboard loaded half) was as good as new after many years of service.

The best scraper for these types and sizes of bearings can be made from a 12" to 18" long wood planer blade properly sharpened and honed to avoid scratching the babbitt. A power hacksaw blade can also be sharpened in a similar manner. The latter has the advantage of flexing enough to give even better control of the cutting action.

Excellent and practical information on bearing scraping and many other gear maintenance operations can be found in NAVSEA instructions, Chapter 9420.

The most annoying problem on *Munro* was that it was impossible to remove the Aft buil gear bearing caps in the normal manner. We had to drive out three taper fit bolts from the gear to line shaft couplings to get the needed clearance.

There are also no provisions made for lifting the Aft intermediate gear and pinion rotor journals when removing the bearing for inspection We had to move the turning gear Aft about 1½" and use a wrapped wire rope sling for lifting. The CGC *Boutwell* design uses large jacking screws for this purpose.

The Port intermediate gear had some old pitting in the Aft end of the Forward helix. The pitting appears to have relieved the hard contacts and now only needs to be watched. The RED DYKEM lacquer coating applied will aid in verifying the condition at a later date.

The only bearings on *Munro* with noticeable wear were the two split ring thrust bearings around the turbine quill shafts just Forward of the "SSS" clutches. Since the wear was only on the Forward face, we simply turned them around to have the good "as new" face toward the thrust load. Next time they will need rebabbitting.

The two turbine quill shaft Aft steady bearings inside the turbine pinions had worn to 0.018" clearance. These were re-babbitted and bored to the latest instructions in Amendment #18 to provide a design clearance of 0.007" to 0.009" *after shrinking into the pinion bores*. The interference fit is quite heavy so it is necessary to chill the bearing in dry ice and heat the pinion to about 200°F.

Since these quill shafts are supported by three bearings it is essential that they do not "fight" each other through misalignment. We checked this by measuring the concentricity of the Aft end of the quill shaft in the clutch housing bearing bore (ball bearing removed).

All of the split journal bearings in these gear units are provided with spanner wrench holes for use in rolling them out or in during inspection. It was found that several could not be turned that way. Instead, we inserted a loop of ¼" wire rope in the oil supply groove around the outside of the bearing. One end was fastened to a bolt in one of the tapped holes in the steel shell of the bearing and the other to a small chainfall or "come-along." This method never fails to rotate any stubborn bearing after raising the rotor a small amount. This is much better than prying with a pinch bar or screwdriver in the oil supply groove.

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Most of the bearing caps had been sealed with a silicone rubber sealant. This is fine in noncritical joints but is definitely unsatisfactory in the horizontal joints of the bearing caps since the rubber film is usually too thick and prevents proper "pinch" of the bearings in the gear casing bore. This tends to keep the joint open enough to allow the bearing halves to vibrate in the gear casing bore.

The silicone rubber film in one diesel pinion bearing (on the CGC *Sherman*) measured .012! Raising of the bearing cap also affects the tooth contact because the diesel pinion operates in the upper half bearings when under load.

We measured this "pinch" by using thin soft lead wire between the cap and the bearing when assembled with 0.004" shim stock in the horizontal joint. Subtract the 0.004" from the lead wire thickness to find the pinch. We used "Permatex #3" sealant which remains flexible and does not open the joint. A small amount was used between the cap and the O.D. of the bearing to provide some damping. If this inadequate pinch persists then the bearing cap horizontal joint face must be machined carefully to close up the bore. The two Aft diesel pinion bearings on *Boutwell* should be inspected again in about 2 to 3 months. These bearings may also be subject to some unbalance forces from the heavy clutches. Measure vibration on the bearing cap as well as on the pinion journal just Aft of the cap at various speeds. Such data can be most valuable in any effective preventive maintenance program.

Main Thrust Bearings

The main thrust bearing clearances had been measured while under way on both vessels using a depth micrometer against the plunger which contacts the rim of the bull gear. This method has tended to give inaccurate data because the plunger needs to contact the gear rim whose surface speed is very high (2200 fpm at 90 SRPM). Clearances taken on *Boutwell* in 1977 were below the design limits of 0.017" to 0.027" and maximum operating clearance of 0.035". The Starboard main thrust bearing clearance on *Munro* was beyond the maximum operating limit. It had been measured at 0.044" with substantial thrust ahead and astern (90 SRPM at ± 0.5 pitch).

The ideal method for measuring the thrust clearance underway at all speeds and without contacting the bull gear rim is to install a Bently-Nevada noncontacting eddy current probe in place of the present plunger in the casing. The bull gear location is measured on a suitable DC voltmeter (0 to 15 v.). These probes can measure gaps up to 0.090" and would resolve the thrust clearance problems easily. Deflection with increasing load can readily be determined at any speed.

The thrust bearing clearance can also be measured statically at pierside. The static method is limited by the fact that there is no suitable location in the engine room against which a hydraulic jack can push when moving the shaft forward. Our check of these clearances at the dock worked quite well. It involved "choking" a ¾" wire rope sling twice around the line shaft as far Aft under the cat walk as possible. The chain fall was anchored to the heavy lifting hooks on the gear casing and to the base of the tank located over the diesel pinion inspection cover. It is necessary to pull hard on the chain falls and also rotate the line shaft with the turning gear back and forth about 4". Measure the thrust clearance with a dial indicator against the Aft face of the torque meter brush assembly. Take two sets of readings. No jacking is usually needed to push the line shaft Aft. Use of the turning gear is sufficient.

The main thrust bearing shoes were barely broken in on *Munro*. Therefore, the excess thrust clearance of the Starboard shaft was corrected by making a new spacer 1.020" thick, 0.018" thicker than the original spacer. The main thrust collars were in good condition with only minor scratches.

On *Boutwell* the main thrust bearings were in perfect condition but all of the fitted studs had to be replaced because the nuts had been overtightened to the point of stretching the threaded portion so badly that the nuts could not be safely reused.

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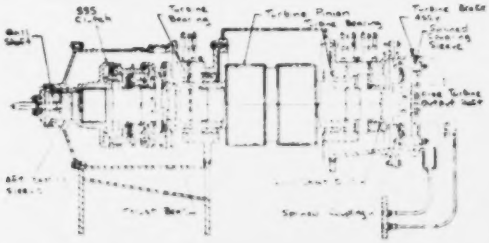
Inspection of the thrust shoes verified that they were in excellent condition showing normal burnishing of the babbitt. There were only a few minor dirt score marks in the babbitt. The thrust collars were essentially as good as new.

Turbine Dental Coupling

The Starboard turbine dental coupling (Figure 4) was "frozen solid" on both cutters due to brake heat distortion preventing the coupling from floating axially as designed. The greater misalignment of the Starboard turbine on *Boutwell* may have also contributed to the severe binding in that dental coupling. We had to use a 50-ton hydraulic jack to remove the hub from the coupling sleeve. The teeth were not scored, requiring only hand polishing with fine emery cloth. However, the tips of the hub teeth had to be cylindrically ground to a smaller diameter to eliminate the interference at the roots of the heat distorted sleeve.

Figure 4. Starboard turbine piston and dental coupling.



The coupling sleeve must not bind in the axial direction. The turbine manufacturer specifies that the maximum axial force should be less than 1000 lbs. The coupling locking force at full power can be several times this amount even with smooth teeth and an assumed coefficient of friction of 0.15. *A momentary slowing down of the turbine after operating at full power for a few minutes will help the coupling find its axial location.*

The turbine brake is preferably to be used only for locking the free turbine. The CGC *Boutwell* has found it easy to stop the main gear by reversing pitch while the clutch is engaged. This will then also stop the free turbine and the brake can be applied.

It is important to match-mark the mating teeth of the coupling as found. Since the hub uses two (02) keys, match-marks are vital here also.

The long fitted studs in the dental coupling are often destroyed when removed by hammer or mallet. The reamed holes also become badly scored.

The method used on the *Jarvis* and the *Mellon* is far superior and harmless. It involves using the 17½ ton push/pull jack mentioned above. Make up a 1 inch diameter threaded rod about 10 inches long with a tapped hole in one end to fit the studs. A 1 inch nut and washer allows pulling the studs about 2 inches each full stroke of the jack.

During reassembly, remove all nicks and burrs from the coupling faces. Tighten the nuts to the correct torgue with the threads well lubricated with either oil or anti-seize compound.

Turbine To Gear Alignment

All four (04) free turbines were out of alignment to their pinions at the dental coupling as shown in the chart on the following page.

The 0.004" vertical misalignment on *Boutwell* compensates for the lifting by the oil film in the Forward steady bearing.

The turbine quill shaft thrust bearings had worn excessively on the Forward face due to the high axial forces created by the bound up couplings. These bearings and the #8 free turbine bearings oppose the thermal expansion of the turbine coupling shafts.

We used the method described in the Summer 1977 Coast Guard *Engineer's Digest* to align the free turbine to the red gear. The secret of success is to support

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	MUNRO	*BOUTWELL*
Port Turbine		
Vertical Plain	.034" High	.004" High
Horizontal Plain	.035" Inbd	.043" Inbd
Starboard Turbine		
Vertical Plain	.030" High	.004" High
Horizontal Plain	.040" Inbd	.077" Inbd

NOTE: These values are actual offsets, not total indicator readings (TIR)

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the Aft end of the turbine coupling shaft with an accurate lifting force at right angles to the axis of the shaft. Only then will the shaft be a true extension of the axis of the free turbine.

We made a "V" support from two pieces of aluminum 2" x 2" angle iron welded together to form an included angle of about 120°. The flats were next to the turbine shaft and were lined with "Teflon" to decrease friction. As an alternate means of support, *Mellon* used a well oiled "Telflon" belt to support the shaft, with excellent results. The support was hung from the 300 lb. spring scale with a small wire rope sling. Check the support for being vertical athwartships with a plumb bob. Move the spring scale fore and aft until the center of the "V" support remains at 5¼" from the Aft face of the turbine coupling shaft as it is rotated. A very accurate spring scale must be utilized due to the flexibility of the Forward coupling on the free turbine output shaft. We found that a deviation of only one pound affected the vertical alignment by 0.0015" or 0.003" T.I.R. The net lifting force should be 237 lbs. for the standard 8 inch diameter coupling shaft. The scale should be calibrated to ensure accuracy (See Figure 5).

The *first check* should be to dial indicate the lateral rim run-out of the Aft coupling flange of the turbine shaft. Its Forward end coupling is a thin diaphram. Therefore, it is essential to spin the free turbine by hand fast enough to allow it to rotate free-hanging several revolutions before stopping. Read the total indicator readings (radially). This will show any permanent set or distortion of the disc coupling. *Next* the parallel misalignment was checked by mounting the indicator on the coupling hub (NOT on the coupling sleeve) using a substantial magnetic base. Take the readings at well marked spots around the rim radially at 90° intervals. Rotate the quill shaft by engaging the turbine clutch and using the turbine gear. Take several sets of readings "on the fly" without stopping. Make sure that the spring scale shows the net 237 lbs. support of the shaft at the 5¼" location mentioned above. Allow for the weight of the cradle and sling. If necessary take readings halfway between the 90° intervals. Plot on polar coordinate graph paper to better visualize the data. See Figure 6.

The *angular misalignment* was checked with the inside micrometer between the

Figure 5. Spring scale calibration curve.

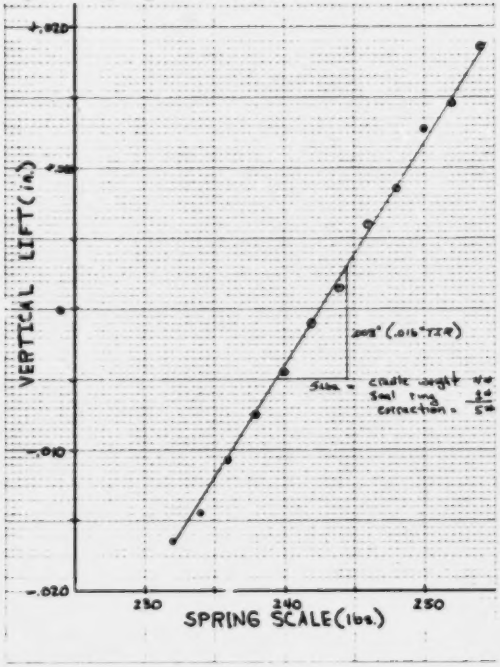
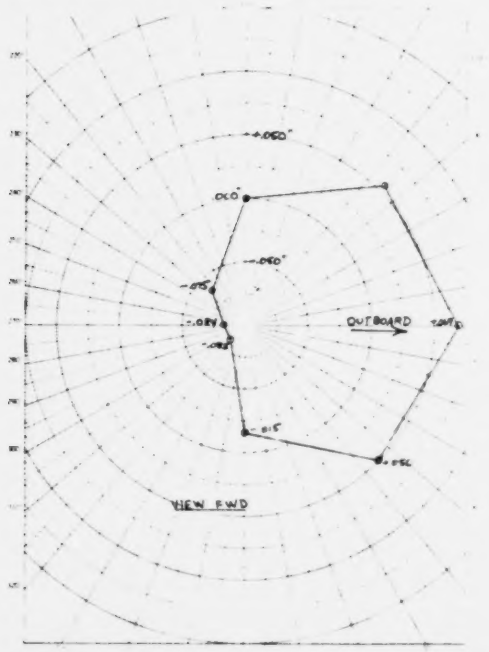


Figure 6. Starboard turbine alignment plot.



Forward face of the coupling hub and the Aft face of the turbine coupling. This necessitated using an accurate straight edge clamped to the coupling face. Take top and bottom as well as side readings.

Angular misalignment generally is no problem in these installations. Interpretation of the data requires allowing for the difference in thermal growth of the turbine supports and their foundation vs. the main gear casing and its foundation.

Correction of turbine-gear misalignment is relatively easy to do in the lateral direction. An eccentric bushing is located underneath the free turbine which can be moved athwartships about 0.200". It was necessary to jack up the free turbine slightly to ease the load of the "Uni-ball" type bearings. As each turbine was re-aligned laterally, it was found that the face (angular) readings improved.

The vertical alignment is more involved. We added "U" shaped shims under the Aft flange of the free turbine inboard pipe support. Had more correction been needed, the same shimming could have been done under the outboard support. Lifting that one flange 0.050" raised the axis of the turbine 0.028" at the dental coupling. The gear casing grows vertically more than the turbine supports. Hence, we aimed to have the turbine about 0.015" to 0.030" high at the dental coupling.

The angular alignment is much less sensitive to changes. We found that it generally improved as parallel alignment was corrected.

Precautions during turbine alignment

(1) The ship must be waterborne and on an even keel. On a hot sunny day it is advisable to take readings very early in the morning. A rainy day is preferred.

(2) Measure the net supporting force accurately. A one lb. error produces 0.003" T.I.R. error vertically.

(3) Allow for the oil film lifting of the quill shaft in its forward steady bearing.

(4) Avondale Shipyard furnished data shows that the gear casing and the turbine thermal growths are not far apart if the ambient temperature is about 70°F or above. The Aft end of the quill shaft is supported by the clutch housing Aft ball bearing. The Aft steady bearing in the turbine pinion tries to lift the shaft. The Port pinion lifts up and outboard and the Starboard pinion moves directly outboard. This influences the Aft steady bearings for the quill shafts.

(5) Slide the coupling sleeve as far Aft on the hub as possible to avoid interfering with the dial indicator and the magnetic base.

(6) Take readings without stopping the shafts.

Refer to Coast Guard drawing 716 WPG-4301-5 dated 11-16-78 for excellent instructions and data. This drawing supplements the above precautions but contains some impractical techniques. The

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reader must evaluate which methods are easiest.

Diesel Alignment

The alignment of a prime mover to a reduction gear is subject to much controversy and misinformation. The aim is to locate the diesel engine so that the axis of the crankshaft is concentric with and parallel to the axis of the diesel pinion within practical limits at operating temperature.

The Forward end of the diesel quill shaft is very flexibly coupled to the flywheel by means of many thin large diameter discs. The shaft bends upward about 0.004" at the labyrinth seal when the heavy clutch is assembled on the Aft end. The air operated clutch acts as a semi-flexible coupling. The large diameter discs also maintain the quill shaft concentric with the flywheel. So, web deflection measurements are no indication of misalignment in this Class of vessels. This disc shim pack coupling is of excellent, maintenance free design. It can easily handle an off-square alignment of 0.0015"/inch of shaft length.

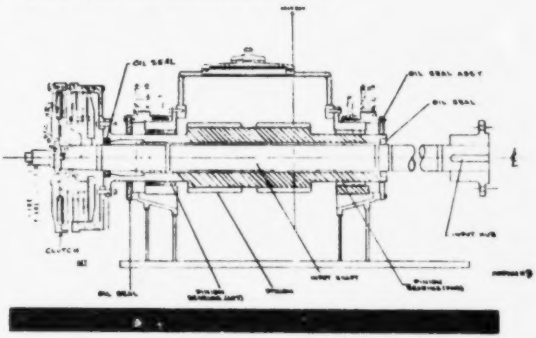
The long quill shaft is mainly sensitive to misalignment at the point where the shaft goes through the labyrinth oil seal at the Forward end of the pinion (Figure 7).

The Aft end of the same quill shaft is supported by the steady bearing in the diesel pinion. This end can therefore be expected to rise by about one half of the diametral clearance of the steady bearing and the Aft pinion bearing (about 0.010" total) plus the thermal growth of the gear casing. The growth of the engine is also involved.

The key concern is to be sure that the quill shaft does not rub in the bore of the labyrinth seal (oil deflector) at the Forward end of the pinion. Any rubbing there tends to bow the quill shaft and the harder it rubs the more it bows to the point where sparks will fly. This can only happen when the clutch is disengaged and either the engine or the pinion is rotating.

The diesel engine alignment is easily

Figure 7. Diesel pinion and clutch.



checked with the use of a feeler gage to find the gap between the quill shaft and the Forward labryinth oil seal in the pinion. (See Figure 8.) The maximum gap limit is determined by the effectiveness of the seal to retain the oil. The CGC *Sherman* had an average gap of 0.102" at the Port shaft and had reported no oil leaks. If the gap is too small severe rubbing will result.

Check the squareness of the quill shaft to the flywheel by means of a dial indicator set-up as shown in Figure 9. Record total indicator readings (T.I.R.) at approximately the 45-inch diameter near the rim of the flywheel. This is a very sensitive and dependable test. Squareness of the quill shaft to the axis of the diesel engine is not apt to be a problem unless the hull has been distorted.

The Port diesel quill shaft on *Munro* had rubbed the labryinth seal at the Forward end of the pinion and had been discarded and replaced with a home-made felt seal sometime in the past. The latter apparently operated well and therefore we made no attempt to replace it. We have since found out that the seal had failed about two years ago and at that time was replaced with a special one made in two halves to allow easy installation. This is an excellent design change and only needed more clearance between the shaft and the bore of the seal to have worked properly.

Hence, the main importance is to insure that misalignment does not cause the diesel quill shaft to rub in the labryinth seal. The

Figure 8. Starboard diesel to gear alignment.

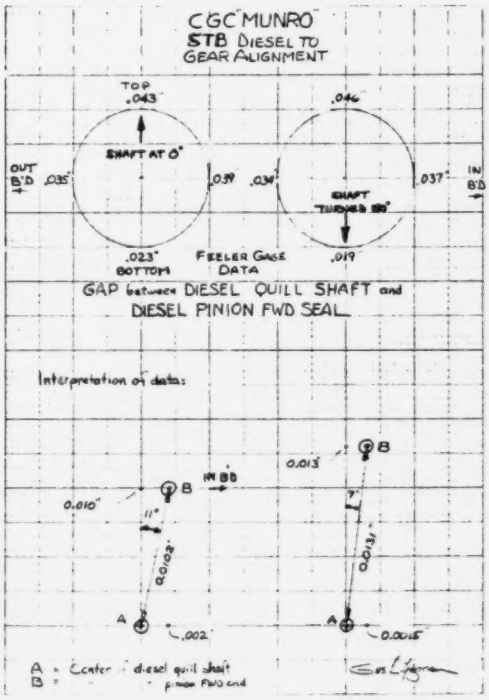
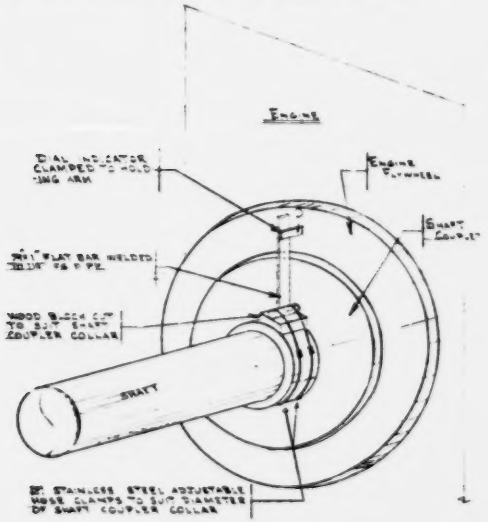


Figure 9. MDE quill shaft squareness check.



clearance in the latter can be as much as 0.100" on the diameter. Oil retention is the limiting factor when determining the gap size.

Clearance measurement of the steady bearing is important but cannot be done directly when the parts are assembled. We attempted to do this by jacking up the part of the diesel clutch which is bolted to the quill shaft hub. Measuring the lift of the shaft in the steady bearing by means of a dial indicator between the two parts of the clutch gave a false clearance of 0.018". This was due to the considerable bending of the shaft by the heavy and overhung clutch assembly. This was discovered after we disassembled the Starboard clutch and shaft. The steady bearing was within drawing limits (0.006"). Hence, it is suggested that this clearance be checked by jacking the quill shaft only after removing the heavy clutch assembly which is bolted to the shaft. But, do not remove the hub.

We worked out a practical method for measuring changes in this clearance which was tried and found to be simple, accurate and time saving. Use a small chain fall to lift the quill shaft part of the clutch and measure the relative motion to the pinion part by means of a dial indicator. This amounted to 0.022" at the Starboard clutch and 0.020" at the Port coupling on *Munro*. Beyond these values the lifting force increased very noticeably. The 0.022" lift produced a downward bending of the quill shaft of 0.012" Forward of the labryinth seal. It is only necessary to remove the top half of the safety guard to make this test. Any increase in these lifts would be direct indication of steady bearing wear.

Some of the original alignment data also is confusing. There is no need to shim the quill shaft central to the steady bearing bore. A major disassembly is involved to reach that bearing. It is not advisable to shim the pinion bearings either. This procedure is too time consuming.

Another problem was uncovered while inspecting *Boutwell* alignment. The clutch hub has a taper fit to the quill shaft. We found that it had been pulled onto the taper

too far, requiring extreme jacking force to remove it. The Technical Manual specifies that the hub should only be "pressed on" 0.063" to achieve the proper interference fit. See Item #11 on drawing 46123R490 or CG Dwg 724 WHEC-4200-52 sheet 12. A simple stop was made to limit this distance when pushing the heated hub (about 300°F) onto the shaft.

Summary of Proposed Diesel Alignment Checks

(1) Remove the Forward quill shaft guard for access to the oil deflector in the bore of the pinion.

(2) Check the concentricity of the quill shaft in the inner oil deflector using feeler gages.

(3) Remove the outer oil deflector and mount an indicator on the shaft to measure the runout on the extension of the Forward pinion journal. Rotate the diesel engine by hand to find the maximum and minimum readings. These should agree fairly close to the data taken in Item (2) above.

(4) Remove the diesel clutch member bolted to the hub on the quill shaft.

(5) Measure the lift of the shaft in the steady bearing by jacking. DO NOT lift the pinion.

(6) Re-assemble the clutch and guards.

"SSS" Clutches (724 Class Only)

The "SSS" clutches were in remarkably good condition. The ratchets and pawls had little wear. Their spring tension was correct. Only a small amount of "mud" was found inside. Minor fretting corrosion had developed on some of the helical splines. The Port "SSS" clutch had a broken interlock pin for the special wrench which is used to lock out the clutch. It is important to use these wrenches without forcing them. *Do not depend on "counting the specified turns of the wrench" when locking in or out only.* The first hand experience of taking the clutches apart was most helpful to allow better understanding for careful operation.

Lubrication

The lube oil flow to each bearing is controlled by a round orifice assembled between two pipe flanges in each supply line. They represent a potential hazard if installed in the wrong locations. Most were inserted between two pipe flanges with a gasket on each side and none were tagged for foolproof identification. They are easily misplaced or lost and are generally not visible between the two gaskets. They are important and must not be omitted or installed in the wrong lines. The diesel clutch does not have an orifice, so it must depend on the hole drilled through the quill shaft. The main thrust bearings require a 0.750" diameter orifice plate in the discharge lines.

The "SSS" clutch orifice is different from the others. It is dumb-bell shaped with a ½" diameter hole through the center.

Each bearing has a sight flow indicator (bubbler). They contain a small nozzle to spray two small streams of oil onto the glass for indication of normal oil flow. Since they are quite fragile and had been repaired often, we replaced all of them with a very simple nozzle made of a short brass nipple with a pipe cap on the end. The pipe cap was drilled with two small holes to give the same spray as in the original ones. These are completely foolproof and are easily cleaned. There is no need to solder or braze them into the bubbler body. The new parts are readily available. Best of all, a substantial cost saving was realized particularly since the old nozzles could only be purchased as a complete assembly of the whole bubbler assembly. This idea should be passed on to the other vessels in this Class.

General Suggestions

(1) Data is needed to show the difference in thermal growth of the diesel engine versus the main gear at the diesel pinion. This can be done by operating for several hours to stabilize the temperatures and then checking the

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feeler gage gap readings between the quill shaft and the labryinth seal. Take the gap readings at the top, bottom and sides.

(2) Develop a practical procedure for minimizing the use of the turbine brake since the brake drum (the coupling sleeve) distorts out of round enough to bind up the coupling. Axial freedom of the dental coupling is extremely important in preventing thrust transmittals to the free turbine bearings, as well as the quill shaft thrust bearing (Forward of the "SSS" clutch or Aft of the SLH clutch). The free turbine is not designed to be subjected to more than 1000 lbs. axial force in order to protect the #8 bearing and the thin single disc coupling at the turbine end.

Replacement of the #8 bearing alone is a tedious and time consuming job. Ask the *Mellon*!

(3) The *Sherman* is prototyping an improved brake design with the extra oil flow for cooling. This should reduce the distortion of the coupling sleeve

(4) Reduce the powerful thrust forces created by the bound-up dental couplings by momentarily reducing the turbine power after operating at high power levels. This will also take the heavy torque off the coupling teeth and help them float axially.

(5) Reduce vibration at the dental coupling by taking advantage of the fact that the Aft end of the turbine coupling shaft is drilled and tapped for balance screws. It is easy to balance the whole assembly "in place" by using an I.R.D. Vibration Analyzer.

One reason this shaft assembly is apt to be sensitive to vibration is the fact that the Forward turbine quill shaft steady bearing is very lightly loaded. This can create an oil whip vibration at a frequency of less than 50% of rotational speed. The vibration amplitude can become violent. Measure the frequency and amplitude of vibration at the Aft end of the turbine coupling shaft using a "V" shaft stick between the pick-up and the shaft. The strobe light gives the angular readings.

(6) Encourage the warming up and circulating of the lube oil before getting underway and use the purifier 100% of the time underway.

(7) The turning gears collect water in the lube oil. Add a small pipe plug to the large one now in the drain to make it easier to remove and check for water.

(8) Inspect and clean the turbine dental couplings more often. Every AA/DD should be sufficient.

Inspection Suggestions

(1) If at all possible, have the gear teeth coated with RED DYKEM lacquer prior to the last voyage before tying up for the inspection.

(2) List the preferred sequence of inspection operations, complete with a check list of tools and materials needed for a major gear inspection like this one.

(3) Perform a diesel alignment check in the hot condition before and after the inspection using feeler gages.

(4) Match-mark important assemblies during disassembly. This includes dental coupling teeth and bearings.

(5) Make alignment checks when water borne before drydocking. If any problems are uncovered then they can be more effectively dealt with.

(6) Make full use of the correct BEARING DRAWINGS when inspecting the bearings or checking the tooth contacts.

(7) If any of the main reduction gear bearings have to be replaced be sure to mark them to indicate "TOP" and "FORWARD." This avoids the serious possibility of assembling the bearing with the wrong anti-rotation lock slot.

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The "BEARING REACTION DIAGRAM" shows how each bearing must be installed.

(8) Use "Silastic" silicone sealant only in noncritical gear casing joints. It leaves a film of rubber which prevents bolting down the bearing caps for proper "pinch" of the bearings. Permatex #3 or the equivalent is preferred. All nicks or burrs must be removed by hand stoning or draw filing.

(9) When all gear inspection work is completed, hose down the inside of the gear casing and the gear rotors by spraying a generous flow of hot oil through the inspection covers. *Munro* utilized its prototype servo heater and oil circulating pump for this operation. They heated about 200 gallons of oil to 140°F by circulating oil through the servo tank. The oil was then pumped into the red gear through a nozzle fabricated out of a 3 foot piece of soft copper tubing. The contaminated oil collects in the gear sump. Clean out the latter very thoroughly when finished with the oil flushing.

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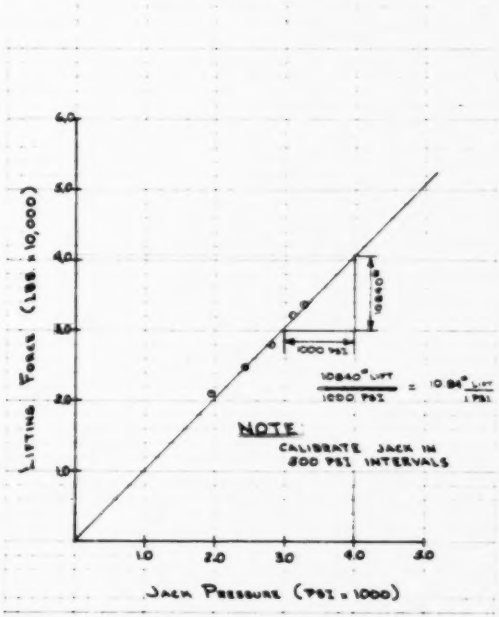
Summary

Many problems were uncovered during the inspection on *Munro* and *Boutwell*. The conditions found on *Boutwell* may have prevented some very serious problems from occurring in the near term. *Munro*'s inspection was accomplished 7 years after construction. The general condition of the gear indicated that the inspection was a little premature and would have been better if done at 10 years. However, thrust bearing, turbine alignment and turbine dental coupling problems corrected on *Munro* did make the inspection worthwhile.

From the complexity of the overhaul, the services of a technical representative are considered both essential and cost effective. Additionally, the inspection results appear to support the Navy requirement of a 10 year major inspection cycle.

Each overhaul was accomplished by the Ship's Force (approximately 1500 man hours and a total cost of $15,000). All figures are per cutter.

Figure 10. Hydraulic jack calibration curve.



About the Authors

LCDR Soland graduated from the U.S. Coast Guard Academy in 1968. He served aboard the CGC's *Staten Island*, *Klamath*, and *Jarvis*. His most recent tour was spent in the Thirteenth District(ene) as the High Endurance Cutter Type Desk. LCDR Soland is presently XO of the Reserve Support Group Seattle (378's) and is employed by the Naval Architecture Firm of Nickum, Spaulding Associates, Seattle, Washington.

Mr. Liljegren graduated from MIT in 1933. He worked 34 years with General Electric Company in gear manufacturing and design, and in world wide field engineering for Marine gears, turbines and generators. His present consulting work covers gear tooth contact problems and corrections.

OUTLINE OF PROBLEMS FOUND

	PROBLEMS FOUND ON: BOUTWELL	MUNRO
1. Shaft weighing foundations missing		X
2. Line shaft bearings too heavy loaded	X	
3. Horizontal misalignment of line shaft bearings		X
4. Bearings requiring renewal	3	0
5. Bearing oil spreader grooves not blended	X	X
6. Crown thickness of original bearings measured incorrectly	X	X
7. Casing bores not parallel to shafts	X	
8. Difficulty in removing aft bull gear bearing cap		X
9. Wrong and too much sealer used on bearing caps	X	X
10. Thrust bearing spacer too small		X
11. Turbine alignment improper	X	X
12. Turbine dental coupling bound up	X	X
13. Lockout tool on turbine clutch broken		X

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Last Manned Lightship Relieved by Special LNB

Mr. Charles W. Scheck
Ocean Engineering Division
U.S. Coast Guard Headquarters

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On 29 October, 1979, a Large Navigational Buoy (LNB) was set on the Columbia River Lightship Station to relieve the last Coast Guard lightship on the West Coast. The LNB is noteworthy because it contains special equipment and has a projected annual savings of $400,000 over the manned lightship.

The new equipment consists of a stronger mooring system, a sophisticated oceanographic and meteorological (O&M) package, nickel-cadmium (NiCd) storage batteries, and a passing light.

The mooring system, designed by Commandant (G-EOE), Figure 1, has an improved energy absorbing ability to resist the forces anticipated at the Columbia Station. Figure 2 shows wear strips which were added to the bottom mooring eye. All 12 Coast Guard LNB's are being altered with the strips in an attempt to extend the four year LNB dry docking interval. (The mooring eye wear is currently felt to be the limiting subsystem rather than the LNB coating system which, if properly applied, lasts about six years.)

Figures 3, 4, 5, and 6 show the major components of the oceanographic and meteorological package. This prototype package is a product of the National Data Buoy Office and provides expanded data to the National Weather Service network. The system uses a General Service Buoy Payload (GSBP) which is a modular baseline system that uses programmable microprocessor technology. It provides O&M parameter data as shown in Table 1 and replaces a wind-speed-only system currently on all LNB's. The sensor configuration and the GSBP satellite communication antenna as installed on the mast are shown in Figure 3. The anemometer devices are on telescoping poles for replacement access and the poles are guyed to prevent whip. Figures 4, 5, and 7 show the installation of the GSBP electronics in the electronic compartment and the GSBP battery banks in the No. 1 engine-generator compartment. The accelerometer which feeds buoy motion data to the wave analyzer is shown in Figure 6. The sea water temperature sensor, which is attached to the bottom of the hull is not shown. A nickel-cadmium battery system is currently being developed to replace the complex gel-cell arrangement

Figure 1. The mooring system.

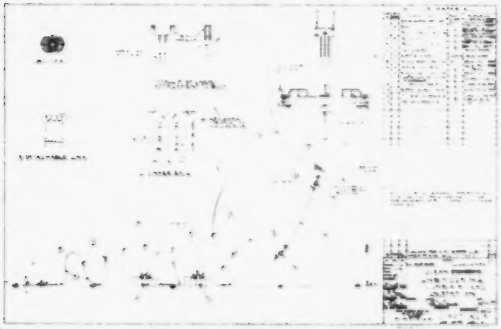

Figure 2. Wear strips added to the bottom mooring eye.

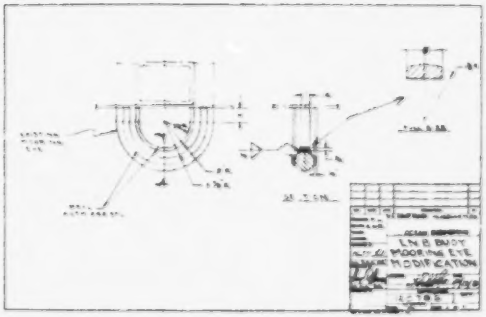

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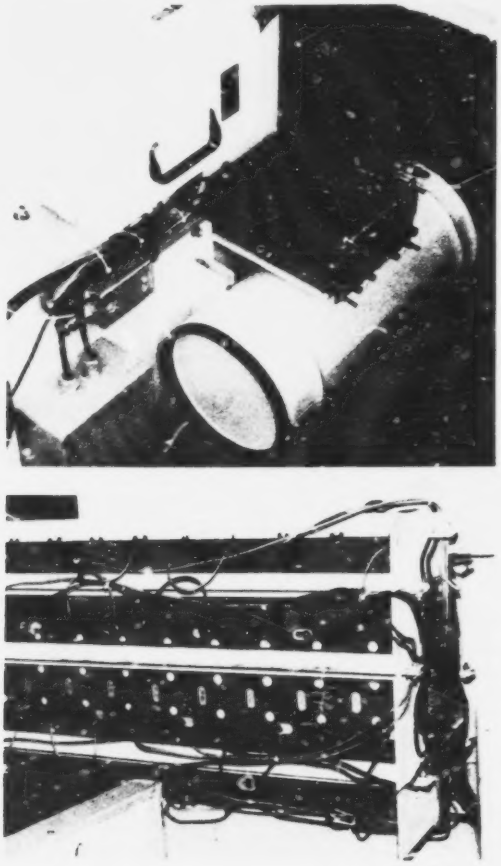
Figure 3. The sensor configuration and the GSBP satellite communication antenna.

Figures 4, 5, and 7. The GSBP electronics in the electronic compartment and the GSBP battery banks in the No. 1 engine-generator compartment.



shown as part of the GSBP in Figures 5 and 7.

The Edison ED-240 nickel-cadmium (NiCd) storage batteries were installed on a trial basis. Figures 7 and 8 show their installation for both 12 Vdc and 24 Vdc buss power. Based on superior NiCd battery performance on fixed lighthouses since 1975, the batteries should prove much better than the lead acid (antimony alloy grid) batteries in LNB service. The NiCd batteries are more rugged physically and electrically and are expected to be superior in performance and life expectancy. This type of NiCd (pocket plate) does not suffer from the "memory effect" as do sintered plate NiCds.

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Figure 6.

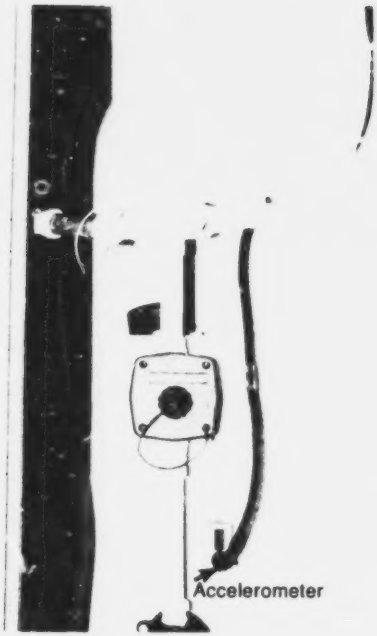
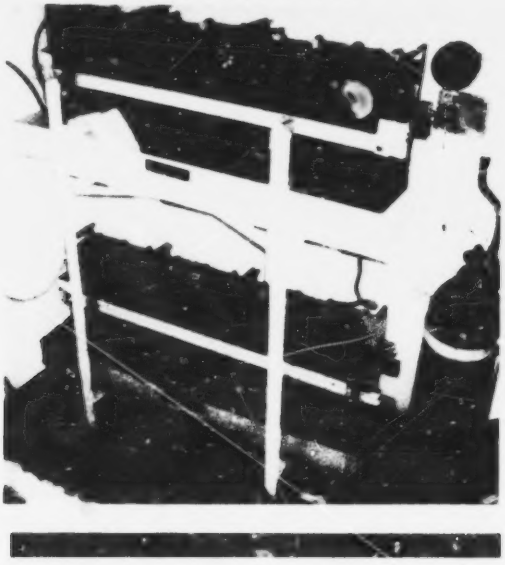


Figure 8. The NiCd storage batteries.



The original lead acid batteries suffered from early physical failure (cell case cracking) and early electrical deterioration because the antimony alloying element in the positive grid plates out and "poisons" the polarization characteristics of the negative plate. This results in the lead antimony battery drawing more and more charging current (at a given float voltage setting), resulting in more and more water loss and eventual serious maintenance and electrical load problems. Further, the conventional batteries are a long (1 year) delivery problem and the NiCd batteries are readily available.

The passing light, a standard 155mm lantern with 2.03A lamp in a six-place lampchanger and CG-181 fixed flasher, was added to give mariners a fixed visual aid when passing the LNB. The passing light is shown in Figure 3.

The buoy was prepared for the Columbia Station by the 12th District as directed by Commandant (G-EOE) and deployed by USCGC *Iris* from the 13th District.

Environmental conditions at the Columbia Station are severe. It is reasonable to expect that maintenance and repair problems will be more than at most other LNB sites and that their solution will be more difficult; however, the only Coast Guard equipment that we fear may be a serious problem is the radiobeacon whip antenna. Commandant (G-EOE) has a test and evaluation project underway to provide a more durable radiobeacon antenna for LNB use on a servicewide basis.

About the Author

Mr. Scheck is a 1957 graduate of Rutgers University and a 1958 graduate of the Coast Guard Officer Candidate School. He served for 17 years with the Third District Civil Engineering Branch. With the Third District he was a working level military engineer, a working level civilian mechanical engineer, and Chief of the Mechanical/Electrical Section. He became Chief of the Ocean Engineering Section in 1970 upon the arrival of the first four 1970 class LNBs which were deployed in and maintained by the Third District. Currently, he is chief of the Support Branch of the Ocean Engineering Division at Headquarters. His branch provides support management services for the Lighthouse Automation and Modernization Project, LNB and other special short range Aids to Navigation Projects required by the Program Manager.

Table 1. LNB Data Requirements

Parameter	Minimum Reporting Range	Resolution	Total System Accuracy
Wind Speed (Avg ≥ 2 min.)	0 to 40 m/s	1 m/s	±1 m/s or 5%
Wind Direction	0° to 360°	10°	±15°
Wave Height/Period	0 to 10 m/3 to 30 sec	0.5 m/1 sec	±0.5 m/±1 sec
Sea Surface Temperature	-5° to 35°C	0.5°C	±1°C
Air Temperature	-20° to +40°C	0.5°C	±1°C
Peak Wind Gust (8-sec avg)	0 to 60 m/s	1 m/s	±1 m/s or 5%
Barometric Pressure	900 to 1050 mb	0.1 mb	±1 mb absolute ±0.1 mb relative

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Organizational Structure: Impact on the Construction Team

LT R. A. Stromsted
Civil Engineering Branch
First Coast Guard District

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The Construction Process

Human desires to maintain or elevate the quality of life and work often lead to construction, either renovating something or building something new. Carrying a large construction project from the conceptual through the design phase requires much effort and time (2 to 10 years for Coast Guard civil engineering construction, 30 years in the case of a major power plant). Investigations, problem solving, planning, developing and comparing designs, budgeting, and acquiring permits represent only a part of the activities accomplished before a project reaches the construction phase.

A project enters its final stage when plans and specifications are ready for issuance to a contractor. Unlike earlier project phases, the construction phase offers fewer opportunities to control construction and future costs: these costs are largely determined by the design. The remaining control over the project's life-cycle costs are still significant though. For example, we can influence the final quality of a Coast Guard facility under construction through our inspection program. This quality affects the happiness of the facility users as well as the money required for future retrofitting, maintenance, and repairs.

Having this prerogative to control construction quality, we should help ourselves by exercising a well-managed program of site inspection, information processing, decision making, and support to Coast Guard site representatives. Good construction and cost savings won't be our only benefits. Our reputation among contractors will improve.

According to statements made by various San Francisco area professional engineers and contractors who were interviewed in 1979, conscientious contractors prefer working on projects with strong, organized inspection. They feel justly treated when work acceptance levels are clear and consistently applied by inspecting officials. An owner with a reputation of fair play will undoubtedly receive a growing number of reputable bidders over the long run. Simultaneously, the number of unscrupulous bidders will shrink.

So, is the Coast Guard's system for controlling project results effective?

Analysis of Factors Influencing Project Effectiveness

The primary construction-team members working on the Coast Guard's behalf are the contracting officer, inspector, and project manager (engineer, architect). Team member personalities, leadership, education, initiative, and skill are fundamental factors influencing the team's ability to achieve satisfactory construction results. Moreover, the organizational framework, which defines lines of authority, communication paths, and the physical locations of personnel, partially shapes team success. Let us more closely study this so-called organizational framework.

Among most district offices and Headquarters units the structure of the construction team is basically triangular as depicted in Figure I. The dominant member is the contracting officer, a member of the procurement staff. The project manager (or another civil engineering representative) and the inspector, both members of the engineering staff, complete the team structure with less influential roles. Limited project controlling authority seems to be apportioned to those with the greatest

Figure 1. Organizational structure of the construction team.

awareness of our desired construction results.

Our present construction-team organizational structure has led to work duplication and sluggish and inconsistent information movement between the field and the office. In addition, support given to inspectors is not as strong as it could be.

1. Information Processing: The construction-phase information cycle consists of field data collection, reporting to the office staff, decision making among office staff, and instructions to the field. As an example, assume an inspector with COR (contracting officer's representative) responsibilities is inspecting a district unit construction project; observing a field discrepancy, the inspector decides to seek permission from the contracting officer to order the contractor to change work in place. The inspector typically calls the civil engineering branch for initial consultation. The civil engineering branch agrees with the inspector's request and directs the inspector to call the contracting officer for an authorization. The inspector then describes the situation to the contracting officer and waits for instructions. During a contracting officer and civil engineering branch meeting, a decision is reached. Eventually, the contracting officer furnishes the necessary order to the inspector. This is just one example among many where inspectors are forced to contact two supervisors. Some inspectors have cited cases of calling the contracting officer and the civil engineering branch several times about a single issue.

Our split construction team structure develops a proneness for us to excessively generate memorandums, xerox papers, and duplicate typing. In the previous example, while deliberating over the inspector's request, the contracting officer may alternatively require the civil engineering branch to furnish a memorandum documenting the engineering recommendations. The civil engineering branch cooperates, then, the contracting officer paraphrases the civil engineering memorandum onto a letter to the contractor.

More evidence of memorandum-and-xerox-"mania" can be observed during ordinary office activities. What happens when contracts are advertised, bids opened, or contracts awarded? Copies of documents involving these transactions are attached to a memorandum from the contracting officer to the civil engineering branch. How do we process a change order? The civil engineering branch issues a memorandum, procurement request, design modifications and cost estimate copies to the contracting officer. Furthermore, district civil engineering branches frequently furnish copies of inspection reports, catalog cuts, and material certifications to the contracting officer.

In many districts, inspection reports, payment requests and contractor submittals make unnecessary stops in the procurement division before reaching the civil engineers for review. Construction status should be reported first to the project manager so an immediate response can be made if needed. Some district engineers claim inspection reports are occasionally not received from contracting officers.

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District offices and probably some Headquarters units seem to be experiencing a fair to poor level of civil engineering/contracting branch cooperation and teamwork. Engineers and architects have reported that, in several instances, the procurement division will not assist an engineer with developing a bidding idea, implementing a necessary change in the field, or condemning a contractor's action when the engineer is convinced this position is correct.

2. Inspector Supervision and Support: Project engineers, branch chiefs, assistant branch chiefs, technical assistants, section chiefs, and contracting officers, all exert supervisory authority over inspectors at various times during construction. Inspector motivation has been damaged because we fail to provide the inspector solid and singular supervision.

Remember the previous example of how an inspector made a request to issue an order to the contractor? When going through this routine, inspectors sometimes receive one instruction from the civil engineering branch then a different order from the contracting officer, according to several interviewed inspectors. The inspector contacts the civil engineering branch and explains the conflict. The civil engineering branch responds: "Do what the contracting officer says." In one case, an inspector revealed that he had to call the contracting officer to learn the status of his request. He was told the contracting officer was issuing the order directly to the contractor.

The inspector does not have a firmly established contact point in most district offices. Supervision during construction should be given to the inspector from one source. Furthermore, the inspector should neither be expected to distribute information to more than one office nor act on instructions issued by different offices.

Results of Surveys

How do other engineers, managers and procurement specialists feel about the organizational structure of a construction management team? From a Coast Guard survey conducted in 1979, representatives from seven of the twelve district civil engineering branches (58%) are in favor of merging the contracting and civil engineering branches under one division. Of the six Headquarters units surveyed, half would favor a merger. On the other hand, district procurement division chiefs, for the most part, oppose any form of reorganization. Six of twelve district procurement chiefs responded to the 1979 survey. The available data, however, points out that only two district procurement divisions would support combining engineering and contracting staffs.

A majority of the city, state, and federal agencies in the San Francisco Bay region report that contracting, construction engineering, and quality control activities are controlled from one office division. The Navy is a big advocate of controlling contractual and technical matters within a single organizational element. As most readers may know, the Navy assigns a Resident Officer-In-Charge of Construction (ROICC), who has an engineering background and contracting authority, to each construction project.

Regulated public utilities, faced with an abundance of technical, contractual, legal, and public problems while accomplishing major projects, feel the most effective approach to monitoring construction is through a project management system encompassing closely joined procurement and engineering functions.

Large owners such as educational institutions and industrial companies either hire professional construction managers to engineer and administer contracts or they charge their own project engineering staff with the engineering and contractual responsibilities. It was also found that many agencies and companies assign their most experienced individuals, who have been promoted through the project or field

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engineering ranks, as their contracting authorities.

These studies of various agencies and companies, responses from our own members, and an analysis of our construction-phase operations lead to the conclusion that a reformed structuring of the construction team is needed.

Unify the Contracting Officer and Civil Engineering Staff

Strengthening office-to-field communication channels, reducing duplicated work, and enhancing team spirit could be accomplished by forming a contracting branch within the engineering division as shown in Figure 2. The contracting branch would perform contract services on behalf of the entire division and in strict accordance with procurement regulations.

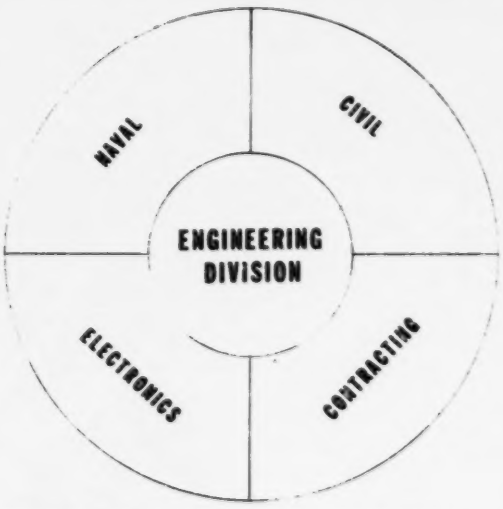

Figure 2. Proposed district engineering division.

The contracting and engineering merger should be attempted in all districts and large Headquarters units. The annual contract volume is probably not large enough to warrant full-time contracting officers in medium and small Headquarters units.

Controlling the Project

Throughout the construction phase the project manager should be the focal point for all project activities. He will monitor construction through the inspector. All contractor submittals, reports from the inspector, inspector requests for technical and contractual assistance, and inspector requests for personnel services shall pass directly to the project manager. The project manager releases the appropriate information to involved parties. The contracting officer forms the interface between the Coast Guard and the contractor. The project manager lead-role concept is illustrated in Figure 3, which shows how support groups and interested personnel interact with each other.

It is possible for the Coast Guard to realize better control over construction results and a reduction in long range costs. By merging the contracting and engineering entities and creating a project-manager lead role, the likelihood of losing information will be lowered, decisions can be reached more rapidly, the clerical workload will decrease, and the project manager will have a better grip on construction status. Further, employee morale and motivation will be boosted, particularly, for the project manager. Having an increased level of accountability for the construction outcome, the project manager will sense greater meaning in the work.

Reference

(a) Stromsted, R.A., "An Analysis of the Coast Guard Shore Facilities Construction-Phase Organization Structure," Engineer's Degree Thesis, presented to Stanford University, California, 1979.

About the Author

Lt Stromsted graduated from the U.S. Coast Guard Academy in 1975. He served as a deck watch officer aboard the USCGC *Resolute* until 1977 when he was assigned to the Twelfth District Civil Engineering Branch. He received civil engineering MS and ENGR degrees in 1978 and 1979, respectively, from Stanford University. He currently is a project engineer.

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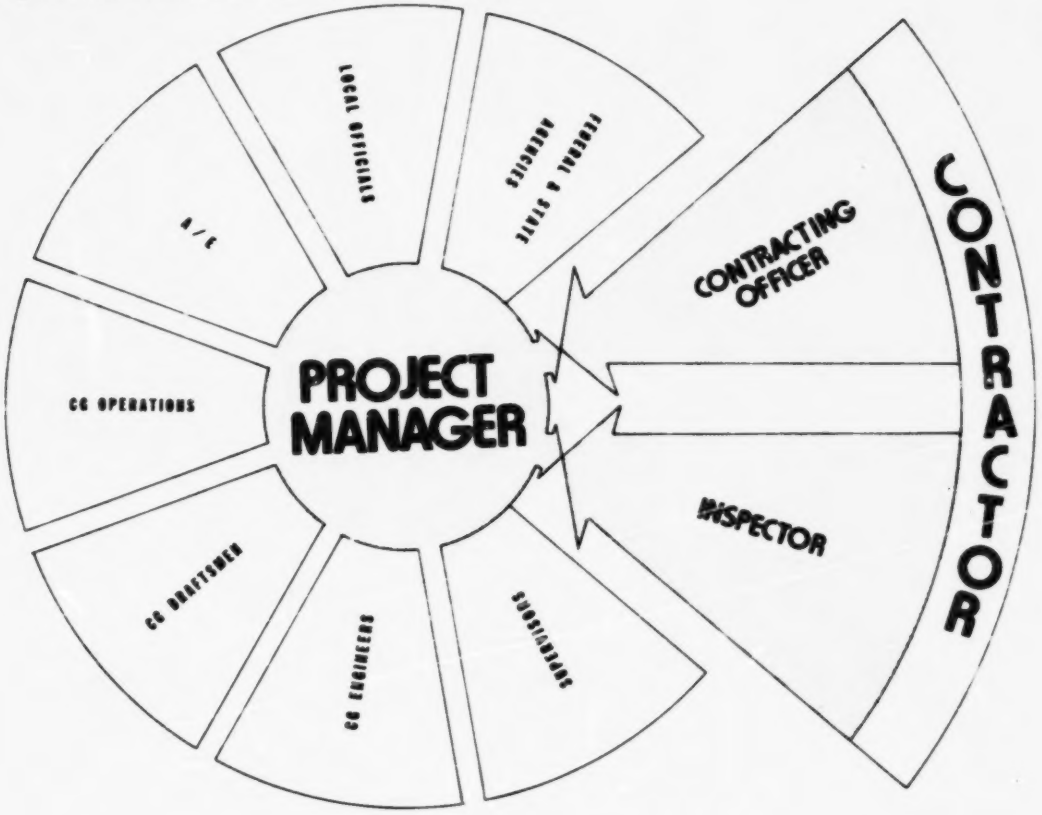
Commandant's Comments

LT STROMSTED makes the following points: that the final quality of a Coast Guard Facility can be determined through our inspection program and that our responsiveness to discrepancies discovered through construction inspection is slow, cumbersome, and wasteful.

The quality level of a particular construction project is rightfully defined by the contract drawings and specifications. The role of the inspector is to insure compliance with the contract documents, not to improve the quality to make up for design deficiencies. It is wrong for the Government to demand more from a contractor merely because it is a "Government Job."

The interaction of engineering and contracting requires the understanding of both parties as to what their respective responsibilities are. Chapters I-6 and II-11 of the Civil Engineering Manual M11000.1 provides specific guidance on Contract Administration and Inspections of Construction. It is recommended that all civil engineers periodically review the requirements of these chapters with their Inspection personnel. It is to the mutual benefit of all parties for professional attitudes to prevail.

Figure 3. Construction team member interaction model.



Lessons From a D-398 Casualty

LT C. E. Porazzi
Engineer Officer
USCGC *Redwood*

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Compiled herein are some observations realized as a result of a casualty that occurred to the #2 main engine of the *CGC Redwood* (WLM 685) in June 1979. The true extent of the casualty was not discovered until August 1979 during an M&R period. Briefly summarized, the ship was at the CG Yard for her Marine Sanitation Device installation. This took approximately three months. While there, the main engine governors and fuel pump assemblies were sent out to be rebuilt by outside contractors. After they were rebuilt, the local CAT dealer installed the fuel pump assemblies and the S/F installed the governors. Upon starting of the #2 main engine, the engine went to an immediate overspeed. The S/F at first, bailed out, but ultimately stopped the engine, as the overspeed trip did not work! After shutdown it was discovered that the fuel rack was stuck at full fuel because a piece of trash had lodged in the helix of one of the fuel pumps (See figure 1). The rack was stuck so hard a pry bar was used by the CAT dealer to get it moving again. The pump was replaced and rack movement restored. Additional adjustments were made to the governor linkage and preparations a little more complete for lite off were implemented and the engine was successfully started. The engine appeared to operate satisfactorily. Pressures, temperatures, and RPM appeared normal. However, when the shaft was clutched in, #6 cylinder would knock as if it had a fuel detonation or delayed ignition. The CAT dealer said the knock was typical of a CAT engine because of the sudden load put on the engine. The onboard engineers, with some operating time with this particular engine, couldn't really tell and surmised everything to be normal. The noise was just something not normally heard before, as the engine is clutched in from inside the control booth.

The ship left the yard and proceeded to her homeport and began working aids. Over 200 hours operating time was put on the engine with this knock appearing when the clutch was engaged and when the engine was loaded by propeller pitch changes and PTO loads. As far as anyone was concerned the engine appeared normal, running smoother than before, the governor controlling the load shifts better than before, but yet there was that annoying knock in #6 cylinder. When the M&R period came in August 1979 it was decided to check the engine further for the cause of the knock. Fuel pumps, lifter height, nozzles, and fuel lines were all checked, adjusted, or changed out as necessary. Still, no remedy for the knock could be found. After consulting with CAT service people it was

Figure 1. Scored fuel pump helix.

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decided that the knock came from late injection or late firing of that cylinder. The cylinder was opened for inspection and the piston showed signs of the valve hitting it (See figures 2 &3). The liner had a groove in it where deformed piston crown metal and the edge of the exhaust valve were rubbing (See figures 4 &5). Last but not least, we found the #4 main bearing with babbitt hanging out into the crankcase (See figure 6)! There was no perceptible bearing metal in the oil, the con rod bearing was in excellent shape and the piston rings were fine also. The con rod was checked and it was not bent. So, what happened?

Figure 2. #6 piston with exhaust valve imprint in relief.

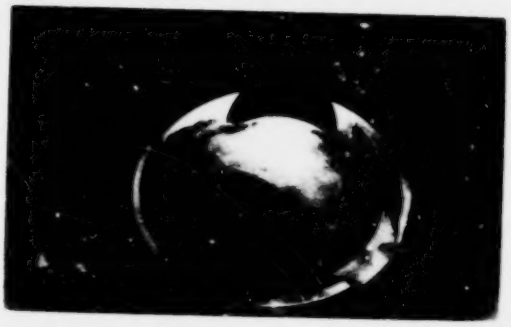
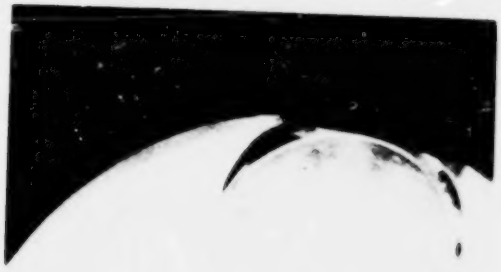


Figure 3. Closeup of valve imprint on #6 piston.



First, when the engine oversped it pegged the tachometers at 1500 RPM but, naturally, the engine was going much faster than that. The engine normally runs at 1250 RPM with

Figure 4. Liner area where exhaust valve edge and piston metal have rubbed.

Figure 5. Area of piston where crown metal is deformed from impact of valve.

the overspeed set at 1426 +/– 20 RPM. As stated previously, the overspeed didn't work (this was due to an internal drive shaft slipping) but could it have worked with the fuel rack jammed as tight as it was? Overspeed is controlled by a centrifugal switch closing, causing a solenoid to divert engine oil under pressure to a small hydraulic cylinder which extends and pushes the rack to the off position. It is felt

Figure 6. View of crankcase as seen when cover was removed. Arrow points to strip of babbitt metal sticking out.

that the cylinder would not have secured the engine in this case, even if the switch had worked. In rehashing the chain of events, the engine took off and scared everybody, but it "leveled out" at some unknown high RPM while the S/F took the breathers apart to secure the air. What had happened was that the valves were floating and the engine had reached its mechanical accelerating limit. Nobody realized the high RPM that was attained at that moment, or the fact that the floating valves kept the engine from literally coming apart. Caterpillar says that the valves will float in a D-398 diesel around 1800 RPM. That is not considered fast for most modern diesels but for a D-398 it is definitely well over the limit.

The second point realized is that after a period of three months layup the engine was prelubed for essentially a normal start. The immediate overspeed upon start caused a tremendous loading on the center main bearing. Actually, the high centrifugal force tends to bow the crankshaft at this point when the engine is unloaded, plus the oil film is not able to support the crankshaft journal for the speed and the unnatural loading being imposed at this point. (This was confirmed with Caterpillar in Illinois.) The bearing failed due to the inadequate lubrication and overloading of the babbitt surface (See figure 7). The babbitt was peeled from the metal backing in strips ½" wide by 6" long. About .023" of metal was removed from the bearing shells (See figure 8). That comes to about .040" total clearance for that one bearing and journal. The normal running clearance is from .005 to .008. Everytime one of the cylinders fired that was supported by that main bearing, the crankshaft flexed! At least .020", maybe more! So, for over 200 hours the crankshaft flexed (causing late firing) the engine knocked upon heavy loading, and all along it was considered to be running well according to the engineers who had lived with this engine for up to a year before this.

Further disassembly of the engine revealed every exhaust valve to be bent with corresponding marks on the crowns of the pistons (See figure 9). There was evidence of the increased loading that was placed on #3 and #5 main bearings. The babbitt on the side towards the bad bearing showed coloration of increased loading. The journal of #4 main bearing on the crankshaft had bearing metal imbedded in its surface and it couldn't be removed by hand, in the engine. All this pointed to an unscheduled center section overhaul with a crankshaft regrinding also being necessary. The contractor that reground the crankshaft later confirmed that indeed we did have a bowed crankshaft, right in the area of #4 journal and it measured around .023". The main engine had 15,000 plus hours on it, and

Figure 7. View of failed bearing showing bearing metal missing. Oil hole is in upper bearing half.

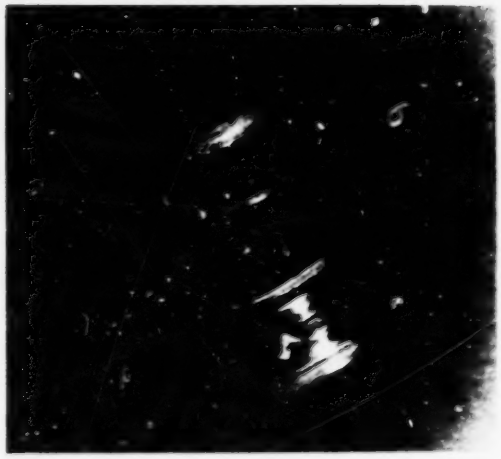


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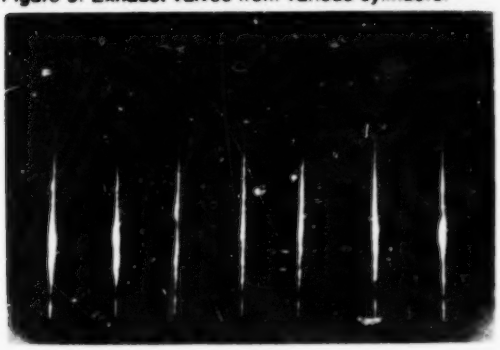
Figure 8. Failed bearing and babbit metal that was hanging off. The larger pieces were free around the journal. The smaller ones were still connected to some bearing metal on the shells.

from the conditions found on the other internals it could have gone around 10,000 hours. This was to be the first overhaul on this engine since it was built and originally installed, but it was really a casualty repair.

Figure 9. Exhaust valves from various cylinders.



What resulted from all of this was an extension of the ships' M&R period to eight weeks: removing the crankshaft from the engine and then from the ship to the machine shop; a complete teardown and cleaning of all essential and associated parts; and procurement of the center section components by District (ene), and preparing and measuring all parts for eventual reassembly into the engine. Coupled with this, we also learned how little *we* actually knew about the D-398 CAT diesel. How little we actually knew from what was written and taught in our CAT school, to what was physically in the engineroom. We learned how little the CAT people knew about their engine in *our* installation! How inexperienced our people were in just the basics of engine teardown and overhaul. And, what a few moments carelessness or inattention can produce. About the thousands of dollars spent to repair what might have been avoided had we had the foresight and not relied on the guesses of "old salts." These lessons are always hard learned and it never seems they are remembered or even documented. The thoughts expressed here are an attempt to correct what has happened in the past, not to fix blame.

The single most serious setback in the rebuilding of the main engine came after the engine had been running about 45 minutes, when it was noticed by an alert watchstander that oil was pouring from the back of the base gasket behind the flywheel housing. An inspection of the area revealed that the gasket had slipped or been cut when placing the flywheel housing on. Another possibility was that when the engine was lifted slightly to accommodate the front accessory cover, this gasket got damaged. This one problem set the rebuild back a week. It was necessary to disconnect the engine from the PTO and reduction gear again and lift the entire engine off the base to replace the gasket. With the increased weight of all assembled engine components and the lack of sufficient padeyes and chain falls, it tested our ingenuity to accomplish this feat. It was done, however, but not without some gnashing of teeth.

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Again, little points tended to crop up that didn't seem to have a concrete solution or a definite applicability to our situation. For example, crank web deflections, Caterpillar engineering practice, and NEM, CG 413, are in conflict about the necessity or the actual location of web deflections. CAT says the crank is designed to be flexible so web deflections will be apparent in just hanging the flywheel on the back of the engine. We tested this information and found it to be true. We had zero deflection until we installed the flywheel, then it rose to .003" and increased another .0005" when coupled to the reduction gear. These figures match previously recorded figures in the Machinery History. CAT recommendations indicate that a check of the center main webs will indicate whether or not any bow has been placed on the engine when bolting it to its foundation. This can be confusing, as we left the base and the foundation in place and removed the block. Also, CAT says deflection should not be more than .001".

After regrinding the crankshaft journals to .050" undersize, the T.I.R. of the #4 bearing journal exceeded CAT specifications for reground crankshafts. The contractor said the journals were within his spec sheets. He was recommended to us by the CAT dealer, but the runout we had didn't match what our spec sheets from CAT said. We then began to wonder what would happen if the reground crankshaft could not be used after all the time and money spent on it? How long before a new crankshaft could be had? The tolerance for a reground shaft is tighter than a new or used crankshaft. What or which condition do we try to satisfy? Many phone calls later, plus a visit from the Third District Assist Team, we verified our findings. The assist team helped us to resolve the differences in specifications and finally make the proper decisions to set a course of action.

All problems encountered during the rebuilt eventually were solved. We did have a successful overhaul, we did have mistakes in putting parts together, and we did not meet our ETR. Even with the frantic attempts made at rescheduling some of the important commitments planned at the completion of the overhaul, we lost valuable ship's operational time.

The engine was runin for a period of time, rechecked, sampled and retorqued, and finally, the ship resumed operational status. In retrospect, our people garnished a great deal of 'experience' and a better understanding of our main engine. Our engineers have confidence in the knowledge gained during this period, but that tends to follow the axiom, "Experience gained is directly proportional to the equipment ruined"! It is hoped from this small account that experience can also be gained from the trials of others. This particular trial cost the Coast Guard $10,000 dollars. That is an extremely expensive 'experience'! We can learn a lot from our equipment just by paying attention to the everyday signals that the equipment sends us; it can also be more cost effective.

The parts removed from the engine that were significant in this casualty were sent to MK School at Yorktown, VA., to be used as training aids. Once again, they are extremely expensive training aids!

About the Author

LT Porazzi enlisted in the Coast Guard in September 1961. His assignments have been USCGC *Tamaroa*, B&ERS New London, Group New London, USCGC *Mariposa* and Group Long Island Sound. He was appointed to Warrant Grade in September 1972, and after DCA training in Philadelphia he was assigned to USCGC *Owasco* as MPA until her decommissioning. His succeeding tours have been MPA, USCGC *Gallatin*, EO, USCGC *Sassafras*, COMLANTAREA (Art), MPA, USCGC *Dallas*, and his present assignment as EO, USCGC *Redwood*. On 1 January 1980, he was appointed to the grade of Lieutenant in the LDO program.

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It Threatens Lives and Tries the Spirits of a Lonely Lightship Crew

Reprinted, with permission, from *National Fisherman*, April 30, 1980, Number 13, Volume 60

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Of all the scourges of the sea, fog is by far the most contemptible. On the lightship *Buzzards* we learned to distrust fog more than the dreaded southwest wind. It became our hated arch enemy. We preferred the hoisting of storm warnings to the invasion of fog, which was cursed more than any other single object, condition, or person.

There are several types of fog, several known causes for its formation, and various reasons for its unpopularity. Dense "pea soup" fog, the kind proverbially sliced with a knife, is the most recognized and understood. Out at sea, this dense fog was rarely so compact that we couldn't see the *Buzzards'* bow from the stern, but we couldn't see much farther than perhaps the length of the ship. Only on a couple of nights was the stern greatly obscured when looking aft from the wheelhouse, and those were abnormal conditions.

This soupy fog hides everything but moisture. At night, deck lights cast grotesque shadows, and encountering a shipmate on deck is similar to encountering an apparition.

This type of fog is definite in its characteristics. When it is with you, it is everywhere. When it leaves, it disappears completely. It may return, but will do so as a body; it does not disintegrate and then mold together again. Ordinarily the sun cannot be seen through this pea soup fog except when at or near its highest point in the sky, which is the only time the soup becomes elastic enough to lessen in texture or content. Otherwise, it disperses abruptly.

We also encounter, for want of a better name, ground, or layer fog. This can be divided further into two branches—one a low layer hugging the water, and the other, a thin layer suspended a few feet above the water. The former is more common.

Layer fog is found primarily on cold nights that follow warm days. It is a close relative of the water vapor that forms when air temperatures dip well below the temperature of the water, and is the coldest of the genus. In layer fog, masts of ships often appear as floating perpendicular sticks without a base, until the rest of the superstructure emerges.

Fog of this kind frequently has been observed on the *Buzzards*. We have seen the flash of Gay Head Light on Martha's Vineyard, 10 miles away, and the red-topped antenna poles in Mattapoiset on the Massachusetts mainland, 20 miles away—all the while squinting unsuccessfully through binoculars for a buoy two miles from our ship.

When a strata of layer fog lies on the water, a landlubber, safely ashore, might think the night completely devoid of atmospheric disturbance. Should he be looking seaward, the lights of large vessels might come into sight, confirming his conviction that the night was perfect, without a trace of cloud in the sky. He would be only partly correct, for the cloud would be upon the water.

Although the mainland may have been visible when layer fog surrounded our position, the fog signal was placed in operation for the benefit of small craft. Anyone who has ever been at sea in a small boat under these conditions can well appreciate the friendliness of such a signal as he listens intently with eager ears. He is reassured by the sound, and sometimes might even become convinced that he indeed is a great navigator.

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We were not specifically opposed to using our foghorn during periods of layer fog because we knew its life was of short duration. We didn't even dignify it by classifying it as a nuisance. In fact, this type can be almost beautiful and is infinitely the most interesting member of the family. It invariably dissipates before the warming sun and soon vanishes.

The second branch of layer fog, that which remains suspended a few feet above water, is quite uncommon. We have seen it only twice on the lightship. It is an actual layer of cloud likened to smoke from a train or a chimney when it is blown on a horizontal plane.

When observed aboard the *Buzzards*, the water was uncovered for many miles and the closer buoys could easily be seen. The hull of a freighter two miles away was clearly sighted but the superstructure of the vessel was not visible. The mainland and the top of Cuttyhunk Island loomed boldly.

Thus we had two extremes, top and bottom, in view but not the narrow belt in the middle. The life of this particular fog passes so quickly one wonders if he actually has been witness to it.

A third type of fog is haze. We call it halo fog or discouraging fog, resembling a huge halo viewed from the *Buzzards*, with the ship being in the center of a perfectly clear area of four to six miles, surrounded by a wide band of haze, or fog. It is discouraging because it lingers.

When Cuttyhunk Island, 4.6 miles to the east, no longer was visible from our ship, we turned on the foghorn. It was exasperating to assume visibility to be 4.5 miles. The final tenth of a mile, held prisoner by the stubborn will of haze, meant being compelled to listen to the horns.

Pseudoaquatic in nature, haze may linger for several days, particularly during summer and autumn. It impedes vision somewhat less drastically than other fog. It can make solo visits or it can bring along a companion—a southwest wind. Smoky southwesters are common to the northeast section of the country and are miserable to endure aboard an unsheltered lightship.

Haze without wind is bad enough, for it means that a fog signal must be sounded. With a violent pitching due to wind, it becomes even more disheartening. On such days, it appears, at first glance, that the visibility is fair to good. However, one's eyes cannot penetrate to the shoreline or to familiar landmarks elsewhere just beyond the fringe.

The crew sometimes refers to haze as a female fog because "it can't make up its mind." It leaves and returns, leaves, stays a little longer, returns again. Indecision is one of its irritating traits.

The rarest formation of fog is the fog bow. It occurred, the few times we witnessed it, about an hour after sunrise. A perfect arch of fog appeared to the northwest. Similar to a rainbow in geometric form, it was not projected as high in the sky nor was it as sharply distinct. There was no coloring. It simply was a bow composed of fog particles. The sun, a bright yellow disk in the southeast, soon consumed the suspended arch.

There are several known causes for the formation of fog. It may develop when warm air, sufficiently high in vapor content, flows over water or land that is cooler than the air. The reverse sometimes is effected when very cold air lies just above warm water or land areas.

It can be caused by radiation due to the cooling of the earth's surface throughout the night. This is more common over land than over water. Radiation fog, when mixed with smoke, can cause the smog that is so common in some of the larger cities. Fog also may occur when warm moist air moves from low to high altitudes and becomes sufficiently cooled in the process. Still another way is the falling of rain through cool air that has a high vapor content.

We were strategically located at the western entrance to Buzzards Bay to provide the mariner with a practical means of determining his position with relation to our

fog signal when visual signals were obscured by fog, haze, rain, smoke or snow. Whether the signals are considered an aid or a defense depends on where a man is situated—that is, on the lightship or on another vessel. Regardless of the point of view, there were two such signals on the *Buzzards:* radio beacons and diaphragm horns.

Radiobeacons are the most valuable of the fog signals. Beacons of the type on the *Buzzards* had a transmitting power that could be heard from 50 to 150 miles. For station identification, most beacons transmit combinations of dots and dashes which can be heard on radio direction finders of ships and boats. Some low-power radiobeacons transmit combinations of high- and low-toned dashes to provide additional distinction to their signal.

Radiobeacons operate during fog, low visibility and on specific clear-weather schedules. This latter operation is for the purpose of extending the usefulness of marine radiobeacons to all aircraft or ships using automatic radio direction finders. Craft employing conventional-type direction finders also are able to make use of the radiobeacons at any time during their assigned sequence.

The next most important signal is the foghorn. Ours was a triplex diaphragm type which produced a chime signal by means of compressed air. Here again the fog signal is distinguished from others by its assigned characteristics, such as tone, type and numbers of sound emissions, and intervals of time between these emissions.

Fog signals on lightships provide a designated number of blasts and silent periods each minute to provide positive identification. This data may be obtained from any chart of an area to which a lightship is assigned.

On the *Buzzards* the horn sounded in groups of two blasts every 20 seconds. There was a three-second blast, a silent period of two seconds; another three-second blast and then a silent period of 12 seconds. From there the cycle repeated itself, over and over and over. During a 24-hour period of thick weather the horn actually sounded a total of 7 hours and 12 minutes.

Should both the starboard and port bank of horns become inoperative at the same time, the ship's bell was used as a standby signal. Strokes on the bell were sounded in groups of two every 30 seconds.

The Light List, CG-158 cautions mariners that the hearing of fog signals cannot be implicitly relied upon, that distance must not be judged only by the intensity of the sound, that occasionally there may be areas close to a fog signal in which it is not heard, and that the mariner must not assume that a fog signal is not operating because he does not hear it.

The influx of fog in our immediate vicinity was dreaded for a variety of reasons. The most noteworthy grounds for this dread were the feeling of being isolated from the world, the grating continuity of the horns and the ever-constant danger of collision.

While on board for our customary 28-day tours, we accepted our isolation, our separation from mainland contacts, but when fog set in, we found these separations more difficult to take in stride. We felt hemmed in, shunned by the outside world. We walked along deck looking seaward or we gazed dejectedly through a porthole. During periods of fog we watched through the portholes more than at any other time, as though some great unseen force was drawing us. We realized how grand, after all, to be able to see lights and land and objects. On clear nights the beach appeared so close, and yet it was forbidden fruit, so we became morose. How lovely that feeling would have been then, if only the damned fog would go away. Fog and water. Water and fog. That gray blanket persisted.

Our ability to think was dulled. We became spiritless. Ship's work continued without enthusiasm. During off hours we wrote to our families, but our letters were vague and poorly worded. We read, but remembered little of it. We watched television or listened to radio, but the radiobeacons interfered

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with reception. The radio became a receiver of beacon tones.

Fog signals were the most distressing elements aboard ship. If you have ever stood on a pier and heard the harsh signal of a ship about to leave for sea, you probably were startled. If you imagine six such blasts every minute of the hour, from a few feet away, you will have some idea of the sound effects of a lightship.

The first such blast always is startling, even to the man who turns on the switch. On one occasion a cook, walking aft toward the galley, timed the initial roar of the horn with an acrobatic toss of a pan of potatoes.

Being fond of fresh air, I slept with two portholes open. One faced in the direction of the foghorn platform, 12' aft and 10' higher than the cabin. There the piercing effect of the horn was most ear-shattering of all. When first assigned to the vessel, I didn't know what to expect and twice was taken by surprise. The noise exploded with a dreadful detonation, and I am quite sure I left the bed, horizontally, at least 6". It was terrorizing.

I soon matured to the invasions of fog and learned to barricade myself hastily. The compressor that furnished air for the diaphragms became my ally. When the man in the radioroom wishes to place the horn in operation he first had to telephone the engineroom for air pressure. The engineer on watch then started the compressor and telephoned the radioroom when the proper amount of pressure had been attained. This process consumed about five minutes.

I always awakened at the first sound of the compressor and, after the first couple of times, knew what to do. I would leap out of bed, close the portholes, make certain the doors were shut and put cotton in my ears. This defense had it drawbacks, for the muffled sound still penetrated the cotton and I never was able to sleep well under those conditions.

The crew's quarters were directly beneath the foghorns, and there was a deck hatch between which normally was kept open for ventilation. On many foggy nights, a skivvy-clad figure could be seen frantically closing the hatch. But there were no sound-proof bulkheads, and the jarring noise continued, albiet slightly dulled. A few of the men slept restlessly; others found sleep beyond reach. Bunk lights came on, magazines were brought out and the unhappy night wore on.

We did, however, adher to the philosophy that it was better to live uncomfortably than not to live at all. It was far better to lose sleep than to become involved in a collision and sleep forever. Then, too, we were doing our job in assisting mariners who ventured into our locale.

The horns reached their maximum volume at the entrance to the wheelhouse. If the door opened while the horn was blowing, the vibration could be felt as well as heard. Papers on the chart table fluttered, the binnacle cover rattled and handrails vibrated. It was without doubt the noisiest explosion of sound one could experience aboard the *Buzzards* lightship. Vibrations could be felt in the arms, the legs, and the eardrums.

We became adjusted to speaking in ways that departed from the norm. We shouted, but even then were forced to repeat ourselves. The most satisfactory method of conversing was the "wait-a-second" routine. We would speak in a normal tone, stop at the beginning of the foghorn, then continue as though nothing had happened. Sometimes it was stop and go several times before a sentence was finished.

We cursed the noise and the fog and the ship and our lot. Finally, on the verge of becoming irrational, we would stop thinking about the horns and seek relief in constructive terms.

Suddenly we would become aware that something had drastically changed. We could hear the dying pulsations of the air compressor and realized that the horns had stopped. The silence was strange, golden. We felt human again. We talked without interruptions. Morale was restored.

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It was strange, but shortly after the horns stopped, the memory lingered no more than a few moments.

The greatest potential danger of fog is the acute risk of collision. This was rarely a topic of discussion aboard the *Buzzards*, other than at abandon-ship or collision drills, which we held frequently.

During collision drills, we first made certain that all hands were topside. Realizing that the expected life span of the ship would be short if struck, it was most important to make sure that no one was trapped below.

In a typical drill, the ship's emergency alarm was sounded several times. The man sounding the alarm shouted "Collision!" and word was passed throughout the ship as men scurried to their places. Each grabbed a life jacket, put it on as he raced topside, and we all mustered in double ranks on the stern near the dory.

After the abbreviated muster showed all hands accounted for, duties quickly were allotted for action to save the ship. We practice shoring and bracing bulkheads, pumping flooded compartments and sealing holes in the skin of the ship. Every man was expected to know the location of each item of damage control equipment and how to use it.

A collision drill usually was followed by orders to abandon ship. Each man went on the double to the boat he was assigned. We had rafts in addition to lifeboats, one on each side of the ship. They always could have been released, provided that portion of the ship was not extensively damaged.

Mariners are expected to use prudence during periods of low visibility. Unfortunately some are careless while others are overconfident. This always brings to mind a quote made by a chief boatswain's mate noted for his vast knowledge of seamanship. He said, "There are old skippers and there are bold skippers, but there are no old bold skippers."

Two close calls involving vessels capable of cutting our ship in half served to emphasize the necessity of an efficient watch and to make us aware of our position as a potential target.

At 3 p.m. May 16, 1956, Louis Schaefer, a seaman from Haddonfield, N.J., had the radioroom watch. Five of us were changing into dress uniforms, for the buoy tender *White Sage* was expected in half an hour to exchange liberty parties. The remainder of the crew was busy below decks.

At 3:10 p.m. Schaefer knocked excitedly at the door to my cabin. "Skipper," he reported, "there's a large ship around here that's getting closer and closer. I can hear its horn but can't see the ship, and it seems to be getting awfully close."

I ordered him to alert the crew instantly. Within seconds everybody was on deck, and many anxious eyes peered into the fog. We stood on the bow and the horn of an approaching vessel confirmed Schaefer's report.

There indeed was a big one out there, and she was getting mighty close to us. Her signal dueled with that of our own foghorn for supremacy of volume. We not only heard a horn searching for us, we could hear the echo of our own blasts reverberating off her hull.

We maintained our disquieting vigil for seven or eight minutes until, at 3:18 p.m., a 300' gray hulk appeared. A moment later it was directly off our bow, no more than a ship's length away, a modern well-groomed military vessel.

Crew members on deck showed much interest in us. They were clearly outlined along the starboard rail, for their ship was headed northeastward. They passed almost directly over the spot where our own anchor dug into the bottom 70' down. We were riding at the five-shot mark that day, a length of 450'.

We exchanged glances with one another and with the men on the other ship. We did not wave because we saw no friendliness or humor in the situation. The navigator had committed the unpardonable. He had

tracked our horn. True, the pilot had his ship under control, but several hundred feet is not a great distance to those who follow the sea.

We had performed our own duties to the best of our ability and had used our foghorn as a guide for all shipping interests. We did not, however, appreciate any pilot who allowed his vessel to remain on a course directly towards us until the last split second when he barely had room in which to maneuver.

Much more terrifying was a similar situation occurring in the blackness of a fog-shrouded night. If sound is infinitely more difficult to trace in a fog, seeing becomes a virtual impossibility, and both are compounded in darkness.

On July 27, 1956, two days after the sinking of the *Andrea Doria,* I was asleep in my cabin. I awakened with a start. The luminous dial of my watch showed 15 minutes after midnight. I sensed that something was amiss.

I jumped out of bed and looked through my screened port. The fog was impenetrable and there were no horns operating! I grabbed the sound-powered phone and called the radioroom. As the watch answered, I heard the beginning strains of the air compressor swinging into action. Simultaneously I heard the roar of a foghorn off our port bow.

"Why aren't the horns on?" I asked with a shout.

"The fog just came in, Captain, and we're fixing to put them on right away," was the answer.

"Do you hear that ship off our bow?"

"Yes sir, I do. I'm going on deck now."

Outside I peered into the darkness, but could see only eddies of wet fog and the beams of our main light as it flashed on and off. The foghorn off our port bow was repeated. A strong tide held our bow into the southwest. That meant the ship was coming from seaward and would therefore pass us as closely as practicable in order to have a good point of departure as he headed east into Buzzards Bay.

At this point our own horns were ready and it was a colossal relief to hear them. They were like beautiful inspiring music and how pleasant they sounded. Again I heard the horn to port, and it electrified me to the world of reality.

We gazed intently toward the direction of the sound. We saw nothing. Fog swirled in droplets. Our foghorns blared their warning. The suspense was eerie. The incoming ship sounded her horn. Deceptively, it seemed to be at our side.

"God," I thought, "she can't miss us." I ran to the alarm lever at the outer bulkhead of the cabin, intending to call the crew to the main deck. "This is what we have been drilling for. This is the real thing. I wonder where she will hit us. How long will we stay afloat?" A lifetime of thoughts sped through my brain during those few terse seconds.

Did I hear a great clanging of bells and a grinding of gears? Is my imagination playing tricks? Are the men on the other ship aware of the drama about to take place?

As my hand touched the lever, a great mass of lights came into view. In that instant I could tell she would miss us. The alarm was not sounded. The ship slid past, a scant hundred yards away. Distance is deceiving, on water, doubly so at night.

Maybe the vessel merely looked huge. Maybe it was 200 yds off instead of 100. The pilot gave no indication of concern. He did not slacken speed, and the vessel passed from view as quickly as it had appeared. It all happened in a matter of minutes, perhaps seconds.

Back in my cabin, I am not ashamed to admit that I prayed. Thanked God for saving the ship and my crew.

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About the Author

George E. Rongner, a native of Cape Cod, Mass., served in the Pacific theatre during World War II, attaining the rank of chief warrant officer in the U.S. Coast Guard. He later served as skipper of two Coast Guard buoy tenders and the lightship *Buzzards*, where this account of fog was written. He retired in 1969, after 31 years service, to his home in Monson, Me.

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A Brief Look at Antenna Arrangement and Testing for Shipboard Installations

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An important part of the electronics design effort for new ship designs (or for major ship renovations) is the placement of the antennas. In this article I will discuss in general terms how antenna placement is done.

The first step in the antenna design process is to establish a comprehensive list of the frequencies that the ship will be required to use, together with the power to be transmitted on each frequency. This information is frequently contained in the Sponsor's Requirements Document (SRD) for new cutter developments or specially developed for renovation projects. (The SRD is prepared by COMDT (G-O) to tell COMDT (G-E) what performance or features are needed in ships that are being designed.)

In designing antenna arrangements for our larger ships, the MF and HF antennas are generally of the most concern. It is usually no problem to place the VHF,UHF, and radar antennas so as to obtain nearly ideal performance. The usual goal is to obtain omnidirectional coverage (in the horizontal plane) for all MF and HF antennas (with some exceptions) plus maximum electrical isolation between transmitting and receiving antennas. The latter requirement usually can be adequately satisfied only by physically separating the receiving and transmitting antennas as far as possible. Also, the performance of the HF antennas, in particular, is quite strongly influenced by the frequency at which they are used. For HF antennas the take-off angle is also of concern, but there is a practical limit to how much that factor can be adjusted by antenna placement.

As in any design effort, the placement of shipboard antennas is an iterative process. After the hull form and superstructure has been established, antennas are selected and "installed." Typically, the first installation is unsatisfactory, so the installation is redone and reevaluated (as described in the following paragraphs) until a satisfactory compromise has been developed.

Obviously, installing, testing, and reinstalling full-size antennas on the actual ship would be an expensive and time-consuming method of conducting an antenna study. A more efficient method, which is frequently used, is to build a scale model of the cutter, install models of the selected antennas in the chosen positions and evaluate their performance. Various arrangements can then be readily evaluated at low cost before construction of the actual ship begins or, in the case of a renovation, the various arrangements can be evaluated without long Yard periods during which the cutter is not available for service. This method does have some limitations, however, such as practical size limits for the model and limits on the radio frequencies practical for model test use. A scale of 1:48 has been used for most of our larger cutters because a smaller scale would make the size of the model too large for handling and a larger scale would make the frequencies too high for practical testing on the model range.

The recent availability of digital computer programs for the evaluation of shipboard antenna installations has made it possible to analyze various antenna arrangements mathematically, although to a somewhat less precise and less reliable degree than is possible with a good model. Approximations must be made in the description of the superstructure and hull form to keep the program size within reasonable limits. Computer running times for each antenna and each frequency are typically several

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hours long, which tends to make this method expensive. However, an analysis can be performed in relatively fewer man-days than the brass model analysis. As a result, a typical antenna arrangement study will follow these steps:

1. Identification of the requirements.
2. Selection of suitable antennas.
3. Preliminary placement of the antennas. This is generally an educated guess based on experience with the antennas and with vessels of similar size.
4. Computer analysis of the preliminary arrangement. This is generally conducted while the brass model is being fabricated.
5. Resolution of problems which are uncovered by computer analysis. The computer analysis might be repeated to verify the feasibility of proposed changes if time and money permit.
6. Model range testing. Various antenna arrangements can be evaluated and the results of the computer study validated during this period.
7. Implementation. The antennas are installed in the positions indicated as optimum by the model tests and computer analyses.
8. Full scale verification. After all antennas are installed, their performance can be tested at full scale at certain, specially equipped facilities.

Depending on the project's time constraints, the type of computer available, and the cost of computer time, steps 4 and 5 may follow step 6 and be used as a check on the model tests. However, as faster computers and more comprehensive antenna design programs become available, a larger fraction of the antenna arrangement testing will probably be done on computers.

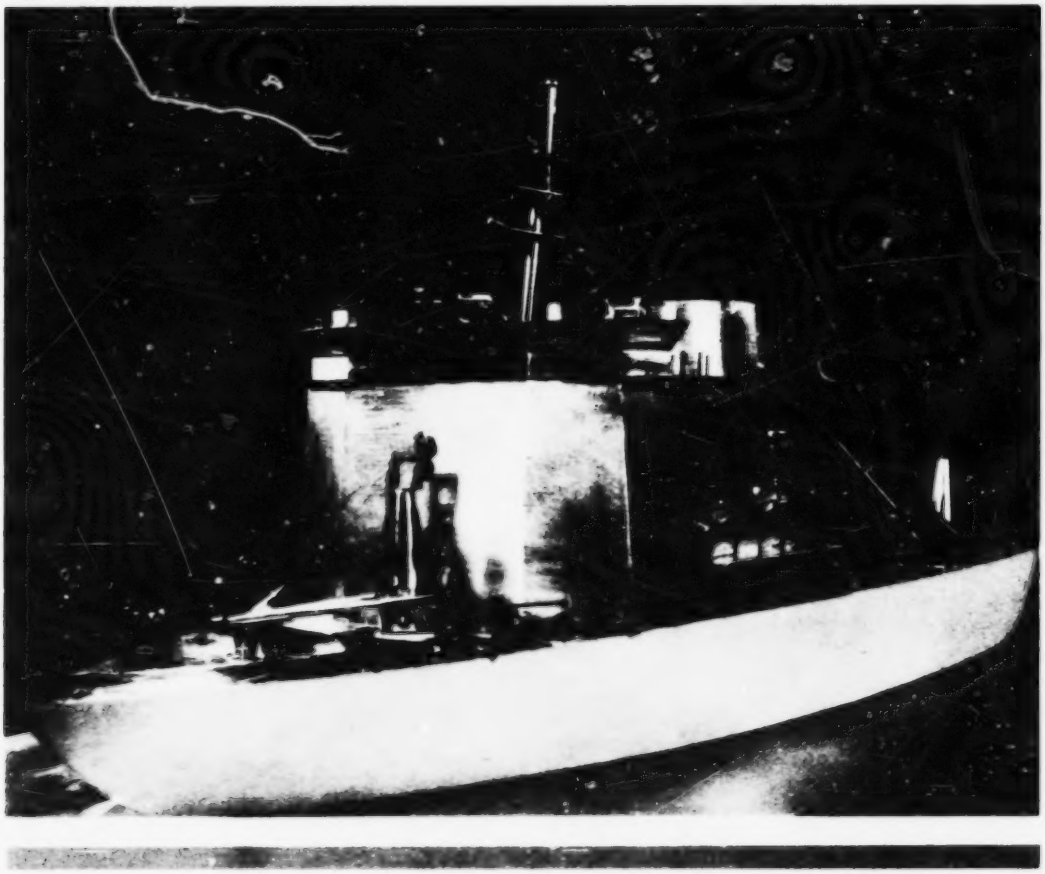
In recent years the Coast Guard has had occasion to contract for a number of antenna arrangement studies, for both new ships and for rearrangements of existing ships. Several of these studies have relied heavily on models to provide the necessary data.

Model tests (of any type) rely on the laws of similitude, whereby some parameter of model performance can be related to the performance of the full scale item by some function of the scale factor. In the case of shipboard antenna tests, the radio frequency at which the model's antennas are excited is inversely proportional to the scale of the model. In brief, model tests are performed in the following manner. A metal or metal-coated scale model of the vessel is built, including miniature versions of the MF and HF antennas. The model is then mounted on a large, metal-covered turntable in an open field. One of the model's antennas is connected to a special receiver, a suitable signal is radiated by a nearby transmitting antenna, and a plot of received signal strength versus vessel aspect angle is obtained as the model is rotated by the turntable. If the full scale frequency is 12 MHz and the model scale is 1:24, the model frequency is 288 MHz, since the radiated frequency (i.e., the model frequency) is inversely proportional to the scale of the model. (Note that model testing for VHF or UHF frequencies would be difficult since the model antennas would be a fraction of a centimeter in size and the model frequency would be in the millimeter wave band.) The process is then repeated with the other antennas, all of which are operated over a range of frequencies chosen to cover the full scale operating range of each antenna. Also note that, due to the reciprocity theorum, antenna radiation patterns are the same whether the antenna is transmitting or receiving. Thus, patterns need only be made with the antennas either transmitting or receiving—not both. This simplifies model testing considerably.

The photographs accompanying this article were picked to illustrate the major concepts and to show the level of detail involved in work of this sort.

Figure 1 is a photograph of a model of an icebreaker currently being designed. The hull is constructed of wood on which a thin

Figure 1. Icebreaker antenna model.



layer of brass has been deposited; the superstructure and fittings are of brass. Figure 2 shows the model mounted on the turntable. A vertical wire behind the model is the transmitting antenna. (More complex transmitting antenna arrangements are used if horizontal as well as vertical antenna polarization patterns are of interest.) Figure 3 shows the surrounding area. Note that the surrounding area is open, free of trees, and flat.

Figure 4 is a photograph of the model built to study antenna arrangements for the 95-WPB rehabilitation program. Only the three HF whips (antennas numbered 1,2, and 3) were tested using this model (note the coaxial cable at the base of the antennas). Figures 5 and 6 are a small sample of the many antenna patterns obtained from this study. Note the effect of frequency on these patterns.

Shortly after the CGC *Cape Upright*, which was the first 95-WPB outfitted with this new antenna arrangement, left the CG Yard, the vessel's antenna performance was tested at full scale at a facility operated by Charleston Naval Shipyard. The process of testing at full scale is similar to model testing except (of course) that the actual frequencies of interest are used and the vessel circles a buoy rather than being revolved on a turntable. Special equipment is temporarily installed aboard the vessel to transmit the vessel's heading to the recording facility ashore. Figures 7 and 8 are a sample of the resulting data. Figures 7 and 8 can be compared to Figures 5 and 6 to observe the similarity between model and full scale data.

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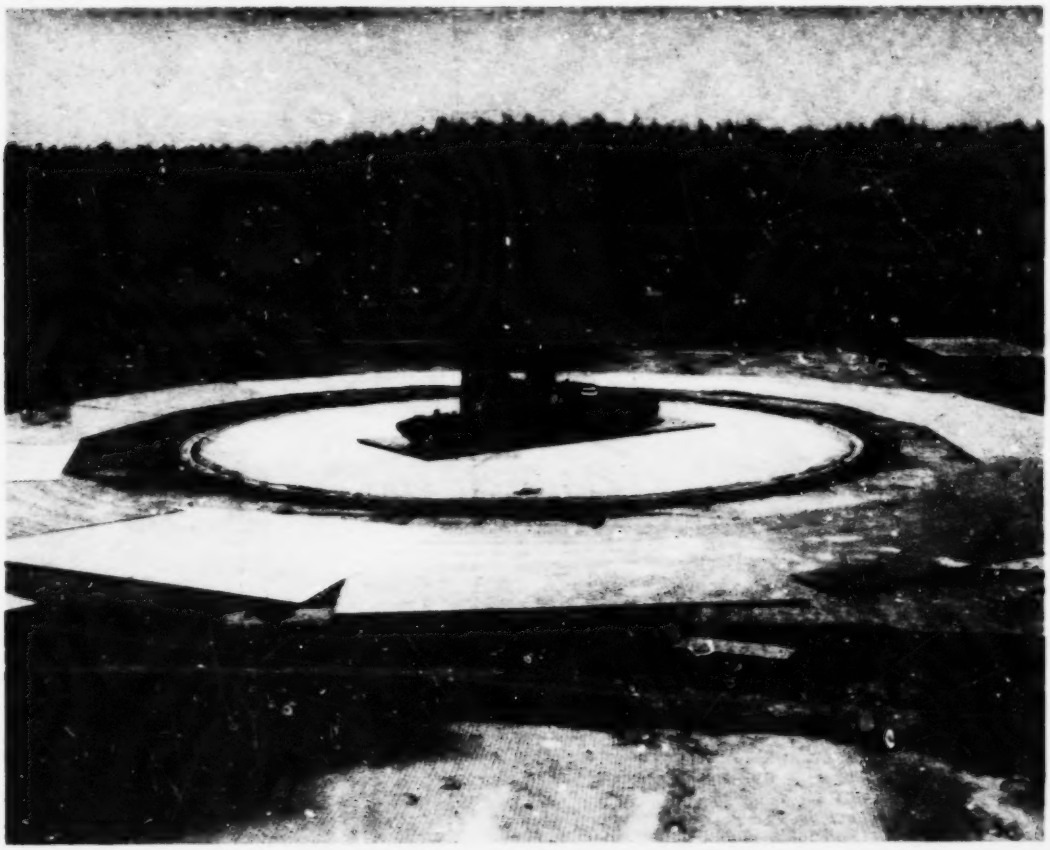
Figure 2. Icebreaker model mounted on turntable.



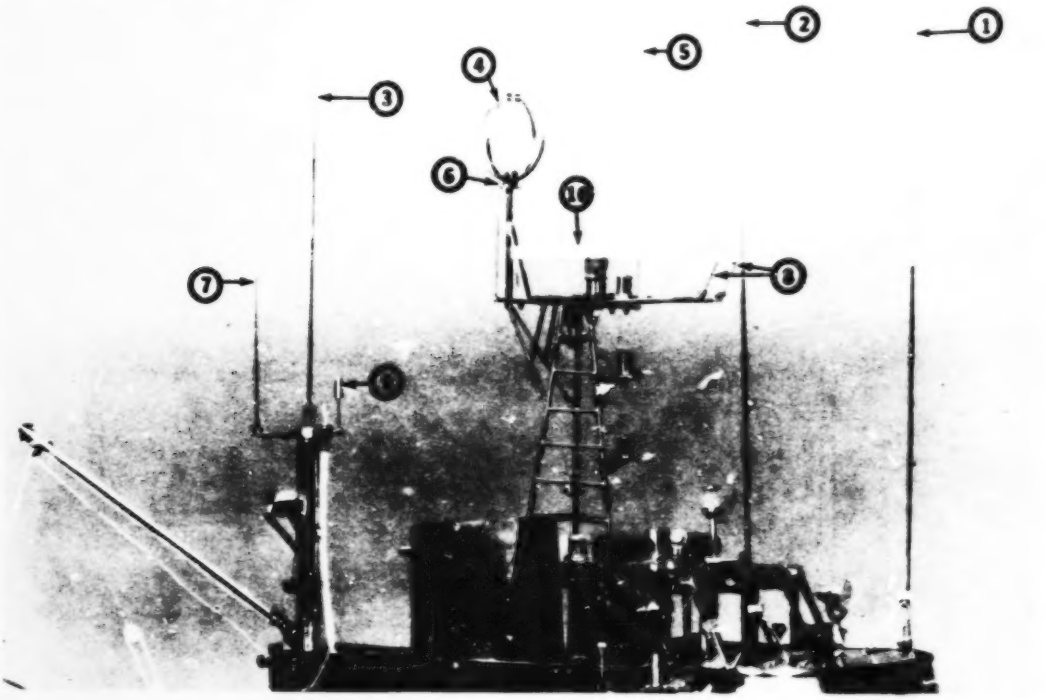
Note that the full scale data is for vertical polarization only.

Figure 3. General view of the antenna test site.

The antenna placement for the 270-WMECs (Famous class) now under construction was studied using both a brass model and computer analysis. Figure 9 is a photograph of the 270 model showing the depth of detail to which the antennas were modeled.

The recent installation of VHF-FM homers, the impending installation of Loran-C receivers and the possible future installation of such things as CB transceivers, a second VHF-FM transceiver, or an HF/CB ADF was the impetus for a recent study of the antenna arrangements on 41-UTBs and 44-MLBs. In this case all testing was done

Figure 4. 95 WPB antenna model.



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at full scale, as only a few antennas on relatively small boats were involved. Since the testing was to be done at full scale, the frequencies to be used would be the actual operating frequencies. Note that antenna arrangement problems are present on small vessels, too. Even though fewer antennas are involved, the space available for use is still very limited. Compromises for optimum antenna performance are always necessary, since an antenna installation instruction typically reads, "antenna should be mounted at the top of the mast and have a clear view in all directions with no obstructions located within 15 feet."

The testing was done by the Naval Research Laboratory (NRL) using a new 41-UTB. NRL has a facility on Chesapeake Bay comparable to the Charleston Naval Shipyard facility and which was used in a similar manner. Various combinations of antennas were temporarily mounted on the 41-footer and their performance measured. Various arrangements were tried so as to identify the most practical and effective arrangement. Figure 10 shows the boat with one of the more complex antenna configurations that was tested. Figure 11 is a closeup of the mast and Figures 12 and 13 are examples of the antenna patterns obtained for the VHF-FM communications antennas. The choice of mounting location for the VHF-FM antennas is an unresolved problem due to a requirement to mount the VHF-FM homer antenna so as to provide optimum performance and, at the same time, mount the VHF-FM communications antennas for maximum, omnidirectional performance. Several ideas that could solve the problem are currently being tested. The best arrangement will be published in a BoatAlt.

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Figure 5. Predicted performance of HF Whip antenna at 7.5 MHz.

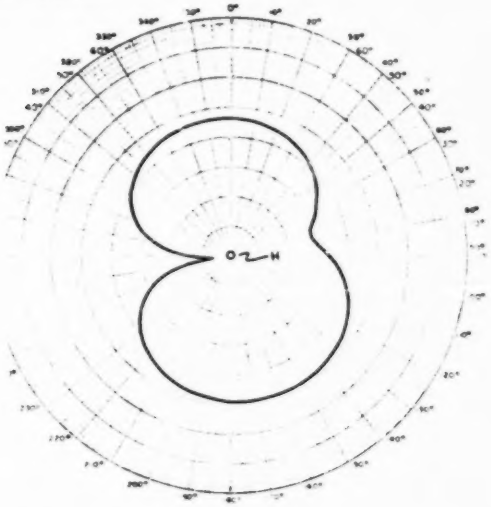

Figure 6. Predicted performance of HF Whip antenna at 15 MHz.

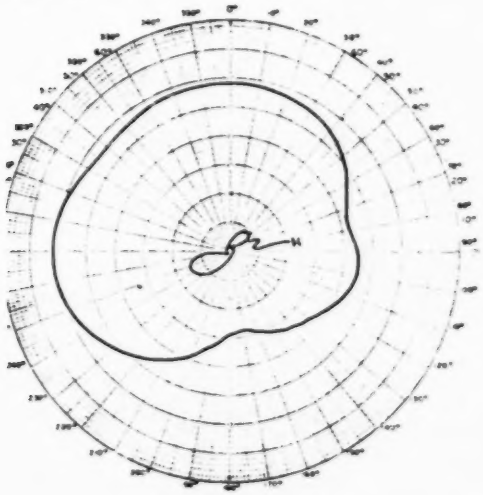

Figure 7. Full scale performance of HF Whip antenna at 7.5 MHz.

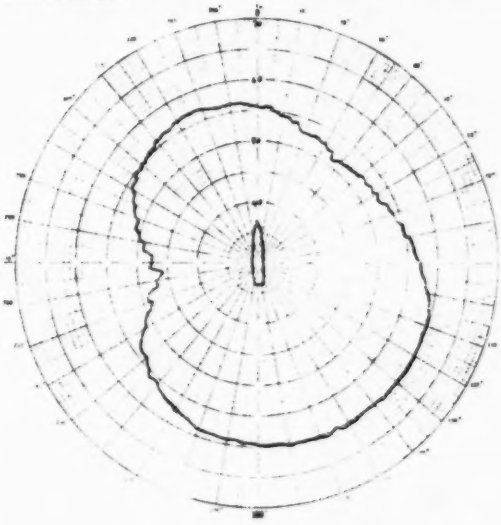

Figure 8. Full scale performance of HF Whip antenna at 15.7 MHz.

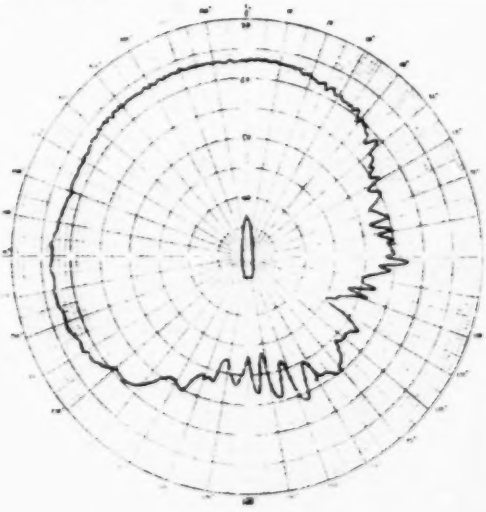

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Figure 9. 270' WMEC model.

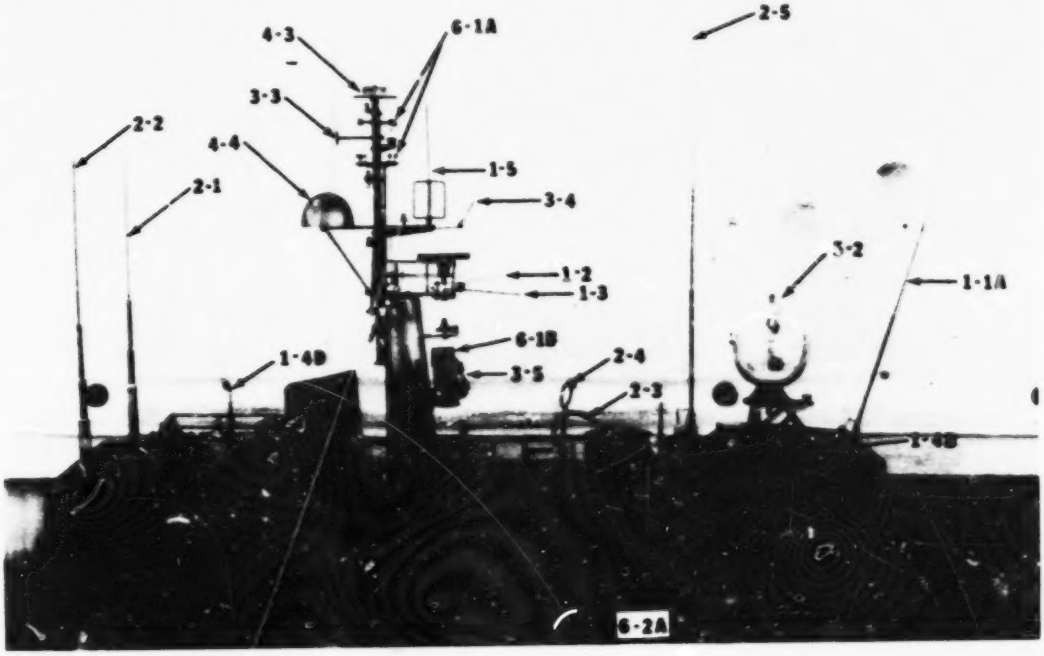


Figure 10. 41' UTB rigged for antenna tests.

Figure 11. Close-up view of antenna on CG41449.

Figure 12. Pattern for single UHF antenna mounted at 45° on mast.

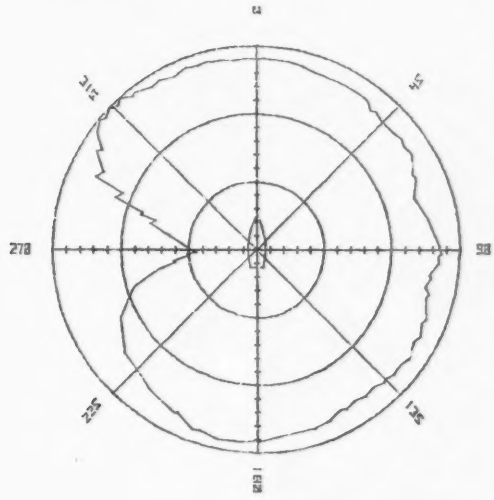
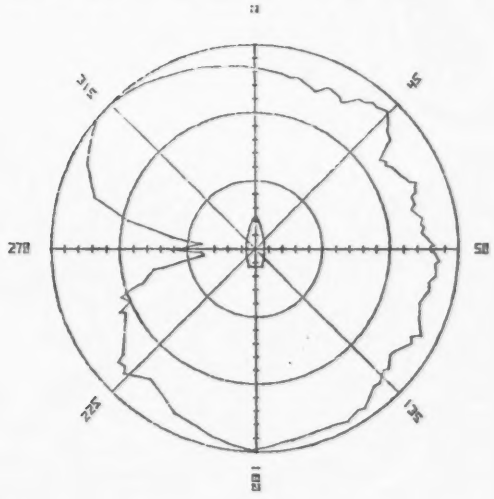


Figure 13. Pattern for a VHF antenna mounted at 45° on mast with similar antenna on opposite side.



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An interesting thought to serve as the "bottom line" to this article is that neither the computer program nor the model studies directly indicate where the antennas should be placed. They only indicate the performance achievable at the location selected by the human in the loop. If the indicated performance is not satisfactory, the human has to decide what can or should be done about the situation.

From the Editor

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- Well, a lots been happening in the last few months: I've been working on getting my sealegs, and I've received many calls requesting copies of past articles which we sent out as fast as possible. We love getting your requests, but what about more comments and suggestions. Barbara and I want to hear from you—good, bad, or otherwise.

  For example, in the last issue, only one person (the author) questioned the caption to Figure 1, page 3. For those who wondered what happened, the wrong caption was inadvertently used; the caption should have read: Artist's rendition of the new 270-foot Medium Endurance Cutter. Accidents do happen, but we need you to keep us on our toes. Some other points of interest are as follows:

- The Marine Technology Society (MTS) is holding their "The Decade of the Oceans" conference October 6-8, at the Shoreham Hotel, Washington, D.C. The conference participants will discuss marine technology in terms of effective application to attain economic, defense, environmental, and societal needs. There will be a large exhibit area of marine products and services. MT-80 is a cooperative effort between the CG and MTS.

- Anyone interested in practical engineering education at the CG Academy should read Professor Boggs' and LCDR MAGEE's article on the subject. You can find it in The Military Engineer, July-August 1980, Vol. 72, No. 468, p. 251.

- The letter on the following page was sent to the 1st District to commend the officers and crew of the *Bibb* for completing its full-power trial in an outstanding manner. As noted, the *Bibb* is 43-years-old. The 327's are older than the oldest ship in the Navy, except for the frigate *Constitution*; the *Taney* saw duty at Pearl Harbor during WWII. These ships continue to demonstrate CG know-how.

- The cartoon on the inside back cover, which has been slightly revised for publication, was presented to Captain H. B. Thorsen former Chief, G-EAE, by the Aviation Branch. Capt Thorsen has assumed new duties at the USCG Academy. He is now the Commandant of Cadets.

- These are just a few of the happenings related to CG engineering. We need your input to circulate information. Please send your articles, comments, questions, suggestions, newsworthy items, etc., to Barbara or me at the address on the inside front cover. Also, we welcome phone calls, FTS 426-1135. Well, I've got to weigh anchor.

Janis

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS: (G-Ei)
U.S. COAST GUARD
WASHINGTON, DC 20593
PHONE: (202) 426-1134

9000
23 September 1980

From: Commandant
To: Commander, First Coast Guard District (d)

Subj: USCGC BIBB (WHEC 31) Full Power Trial

Ref: (a) CO BIBB message 3000 DTG 221815Z July 1980

1. Reference (a) stated that BIBB conducted a Full Power Trial and the Acceptance Trial RPM had been equaled, more than forty-three years later! This feat was a direct result of the outstanding maintenance performed by the BIBB crew.

2. This accomplishment is truly remarkable and exemplifies the Coast Guard's "can do" spirit. Please pass my personal "congratulations" to everyone who contributed to the Full Power Trial, especially the Commanding Officer, CDR RISINGER and the Engineer Officer, LT RADACHY.

D. C. THOMPSON
Chief, Office of Engineering

Copy: CO, BIBB

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U.S. DEPARTMENT OF TRANSPORTATION

The Coast Guard Engineer's Digest

COMPLETED
47

ORIGINAL

CG 133
Volume 21

Number 209
Winter 1981

The Coast Guard **Engineer's Digest**

United States
Department of Transportation
CG-133

Chief, Office of Engineering
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The Coast Guard **Engineer's Digest** is an official publication of the Office of Engineering, U.S. Coast Guard Headquarters, Washington, D.C. Now published quarterly, the **Digest** has been a medium for communicating new ideas and technology of interest to Coast Guard engineers since April 1933.

The **Digest** is a professional journal for the publication of research papers, special studies and general interest articles aimed at advancing engineering in the Coast Guard.

While some material for the **Digest** is reprinted from other technical publications, most papers are submitted from the field by Coast Guard engineers and engineering managers, both military and civilian.

The Office of Engineering encourages all Cost Guard personnel in engineering-related fields to share their ideas and experiences, successes and failures, with the Coast Guard engineering community by submitting articles and papers for publication in the **Digest.**

Observe the following guidelines when submitting material for publication:

- Manuscripts should be typed double spaced on one side of 8 × 10½ or 8½ × 11-inch white paper, leaving at least a 1-inch margin on all sides.
- Original articles by Coast Guard personnel (civilian and military) should have a byline, giving name, title, and unit, and a short biography of the author.
- Illustrations—glossy black and white photographs or line drawings—should be approximately 8 × 10 inches in size. In cases where the author does not have adequate facilities for producing finished art, the **Digest** can have artwork made up from the sketches.
- Complete figure captions and figure numbers should be listed on a separate sheet of paper or taped to the back of each illustration. Do not use staples or paper clips on photographs. Protect illustrations for mailing by placing them between pieces of stiff cardboard.

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This publication is intended for all hands. Commanding Officers should take the necessary steps to make it available to all military and civilian personnel within their commands.

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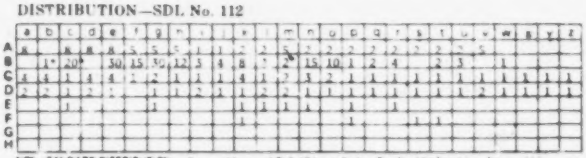

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The Rush for Tighter Buildings Part I: Insulating Coast Guard Stations Now

LTJG D. G. Westerholm
State Liaison Officer
Fifth Coast Guard District

LTJG W. D. Eley
Civil Engineering Branch
Fifth Coast Guard District

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Introduction

Recent on-site technical surveys of Fifth District stations have emphasized the need for adequate insulation in our dwelling and station buildings. Since the majority of Coast Guard buildings were constructed with little or no insulation, the job of retrofitting insulation for shore facilities has become one of the major objectives of the Fifth District energy conservation program. Energy economic analyses have shown excellent simple-payback periods ranging from 2 to 4.7 years (3.2 year average) for the 12 insulation projects scheduled by the District this year (FY80). Furthermore, annual savings from the three insulation projects completed last year are estimated to be more than $6,000.00. These projects were completed at a cost of $18,000, yielding a three-year payback period.

The engineer, when considering insulation retrofitting, can easily lose sight of desired goals when confronted with the voluminous amounts of data available whenever the energy conservation game is played. Being at best a pararesearcher working under a time crunch, the typical engineer can only tread through immediately available information often being forced to make simple algebraic application to determine what insulation best suits his structure's needs. Identifying basic qualifiers such as simple payback periods, cost effectiveness, magnitudes of possible undesirable results, and convenience of installation, the engineer will draw acceptable, but not necessarily consistent, conclusions to use in choosing the optimum method of insulation. To help keep things in perspective, minimize inconsistent evaluations and best utilize the results of our research, the Fifth District (ecv) has developed comprehensive specifications to be used for insulation of most shore facilities. This article elaborates on some of the factors considered as these specifications were developed.

Within the Fifth District, there are basically two station building types. One is the familiar 1930-vintage, wooden structure built with 2 × 6″ studs and covered by wooden siding (most of these buildings have since been covered with insulated aluminum or vinyl siding). The second type is the more modern multi-purpose structure having exterior walls constructed of 8″ concrete block and a 4″ brick veneer with a 2-3″ air gap separating the two. Detailed comparative studies on insulation (see Tables I and II) have shown that different types of insulation are needed for these applications.

Cellulose Insulation in Wood Frame Building Walls

While time has proven that our older Coast Guard stations were built to last, they were also built for cheaper fuel prices and in an age when central heat and air conditioning were not the mode. Even with insulated siding (⅜″ insulation board), these buildings are extremely inadequate in terms of energy efficiency. Typically, walls average R-4.7—low enough to make retrofit insulation a necessity. It was determined that while fiberglass and rockwool are well suited for attic and floor insulation, they are very impractical for retrofit wall insulation. Other types of wall insulation such as

urethane, perlite, or urea formaldehyde foam were either cost prohibitive or unsuitable for wall insulation (e.g., polyurethane releases toxic fumes, see Table I). We have concluded that, in terms of overall energy efficiency and cost of installation, blown in chemically treated cellulose is the most cost effective insulation available for wooden structures. Because in the past many problems existed with installation of interior cellulose, we felt it necessary to research application procedures carefully. After compiling data from numerous sources (including federal agencies, manufacturers, and installers), we were able to develop a suitable performance and material specification. Work done under these specifications has been of excellent quality and has resulted in 20 percent fuel savings.

Foam Insulation in Masonry Construction Buildings

The Fifth District currently has 11 brick and masonry type multi-purpose stations constructed without exterior wall insulation. Insulation retrofitting of these structures poses particular problems. The 2-inch wall cavity between the brick and concrete block has many mortar and wiring obstructions which inhibit proper distribution of cellulose. This type of building can only be insulated by using components that flow evenly around obstructions and into voids, finally "setting" for uniform adhesion and coverage throughout the wall space. Two foams, polyurethane and urea formaldehyde, were candidates. Polyurethane, while possessing the higher value, (21 for 3" layer) releases toxic fumes when ignited; in contrast, urea formaldehyde releases virtually no toxic fumes upon ignition. Furthermore, it does not expand to exert pressure on surrounding walls as polyurethane foam does. For these reasons, urea formaldehyde foam has been a popular choice for retrofit insulation of masonry construction buildings nationwide.

U.S.C.G. Station Little Creek, Virginia Beach, VA. When this station was built no one could have anticipated the magnitude of today's fuel shortage . . .

U.S.C.G. Station Stillpond (1968), Kent County, MD . . . . Nor thirty years later, just before the dawn of the energy crunch.

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Urea formaldehyde (UF) foam insulation is produced on-site when UF resin, an acid catalyst or hardening agent, and air are combined into the wall cavity through small holes drilled in the mortar joints. Polymerization occurs within one minute after installation creating a stiff, self-supporting foam.

In 1979, Massachusetts banned the use of urea formaldehyde foam insulation after homeowners filed numerous complaints of irritation and breathing difficulties associated with formaldehyde vapor emission. By October 1979, the Consumer Product Safety Commission had recorded 485 incidents of reported problems from the release of formaldehyde vapor into homes that had been insulated with UF foam. These problems stemmed directly from the objectionable olfactory properties of formaldehyde. High reactivity of the vapor causes formaldehyde irritation in the mucous membranes of the nose and eyes upon contact and the respiratory tract upon inhalation. Discomfort from the odor and irritation is so severe that individuals would normally leave the area of exposure before physical damage occurs.

In December 1979, the Department of Energy's Residential Conservation Service Program proposed standards for UF foam insulation which would insure a greater level of safety and effectiveness in future installations. We looked closely at their proposals to determine if that level of safety and effectiveness was one with which the Coast Guard would feel comfortable. Formaldehyde vapor is initially introduced into a living space when formaldehyde, in aqueous solution, evaporates from the UF foam during the final curing or drying (usually 2–4 weeks). This amount of "off-gassing" is proportional to the amount of free formaldehyde in the resin. DOE's proposals limit the amount of free formaldehyde to 0.3 percent by weight for fresh urea formaldehyde foam [1]. We calculate that the use of such foam within two walls of a 9′ × 16′ × 16′ corner room would yield a concentration of 0.8 parts per million (ppm) by volume in air if all the free gas was released into the room instantaneously. By comparison, the Occupational Safety and Health Administration has set the threshold limit value for formaldehyde gas at 3 ppm. Studies indicate that 5 ppm is the minimum value at which exposure to formaldehyde gas causes discomfort and irritation [2]. Leading manufacturers of urea formaldehyde foam and the National Association of Urea Form Insulation

TABLE I
INSULATION COMPARISON CHART

	CHARACTERISTICS					
TYPE OF INSULATION	FIRE HAZARDS	WATER ABSORPTION PERMEABILITY	R VALUE (NOTE R VALUES ARE ADDITIVE)	TYPICAL METHODS OF INSTALLATION	NEW BUILDING & RETROFIT RATIO COST FOR EQUAL ASSUMING FIBERGLASS BLOWN = 100	RECOMMENDATION FOR USE IN CG FACILITIES
Extruded polystyrene	Combustible Contains fire retardants but once ignited gives off toxic fumes	permeability (Perm-inch) - 1.2 water absorption by volume - 02%	3 - 12	Performed cut-to-fit glue to wall-cover	New 116	Should be used during original or new construction especially easy to work with
Expanded polystyrene (beadboard)	Combustible Can be fireproofed but once ignited gives off toxic fumes	perm-in 2-5.8 water abs 2.5%	3 - 10.5	Heat & mold cut-to-fit glue to wall-cover	New 75	Covered under block construction but can't be used for finished surface
Polyurethene	Combustible Contains fire retardants but once ignited gives off fumes	perm-in 1.4-1.6 water abs 17%	3 - 19	Performed cut-to-fit glue to wall-cover	New 61	Covered under block construction but can't be used for finished surface
Cellular glass board	Noncombustible	Perm-in 0.0 Water abs 2%	3 - 9	Performed cut-to-fit glue to wall-cover	New 178	Can be used in dwellings No toxic fumes
Polyurethene foam	Combustible Contains fire retardants but once ignited gives off fumes	Perm-in 2.3 Water abs 2-3%	3 - 21	Drill holes in wall need foam machine cover	New 69	Cannot use in dwellings
Urea Formaldehyde	Noncombustible below 1208 F	Perms 32-38 Water abs 2%	3 - 14	Drill holes in wall need foam machine cover	Retrofit 115	Excellent for finished walls (CMU-brick) construction
Perlite (loose fill)	Noncombustible	Is permeable because of loose fill Treated for water repellency	3 - 8.3	Pour by hand	New 216	Best for initial construction filling CMV's
Vermiculite (loose fill)	Noncombustible	Is permeable because of loose fill Water abs 500%	3 - 7	Pour by hand	New 254	Good for initial construction fill CMV's
Fiberglass batts and blankets	Combustible Once ignited releases smoke fumes (see chart Table II)	(Vapor Barrier Needed) Available with vapor barriers like aluminum foil and Kraft paper	3 - 11	Lay in attic staple to walls and underneath floor	New 102	Best for attic and floor insulation
Fiberglass loosefill and blown	Combustible Once ignited releases smoke fumes (See chart)	Loose fill may need vapor barrier	3 - 6.6	For walls drill holes and need blowing machine	Retrofit 100	Good for attic ins Fair-poor for wall insulation
Rockwool batts and blankets	Combustible Once ignited releases smoke fumes (see chart)	Perm-in - 116 Vapor barrier may be required	3 - 11	Lay in attic staple to walls and underneath floor	New 89	Best for attic and floor insulation
Rockwool louse fill and blown	Combustible Once ignited releases smoke fumes (see chart)	Loose fill may need vapor barrier	3 - 9-10	For walls drill holes and need blowing machine	Retrofit 90	Good for attic ins Fair-poor for wall insulation
Cellulose loose fill	Combustible Once ignited releases smoke fumes (see chart)	Loose fill may need vapor barrier	3 - 11	For walls drill holes and need blowing machine	Retrofit 85	Best for wall ins. 2 x 6 studs see paper

Notes: 1. All types of insulation which are combustible may be fireproofed to varying degrees.

2. For those insulation applications which might need a vapor barrier — a minimum of two MIL polyethylene gives less than one perm-in.

3. Fiberglass comes in varying degrees of quality. R values both above and below the given numbers can occur. R values shown here are considered to be the commonly accepted average.

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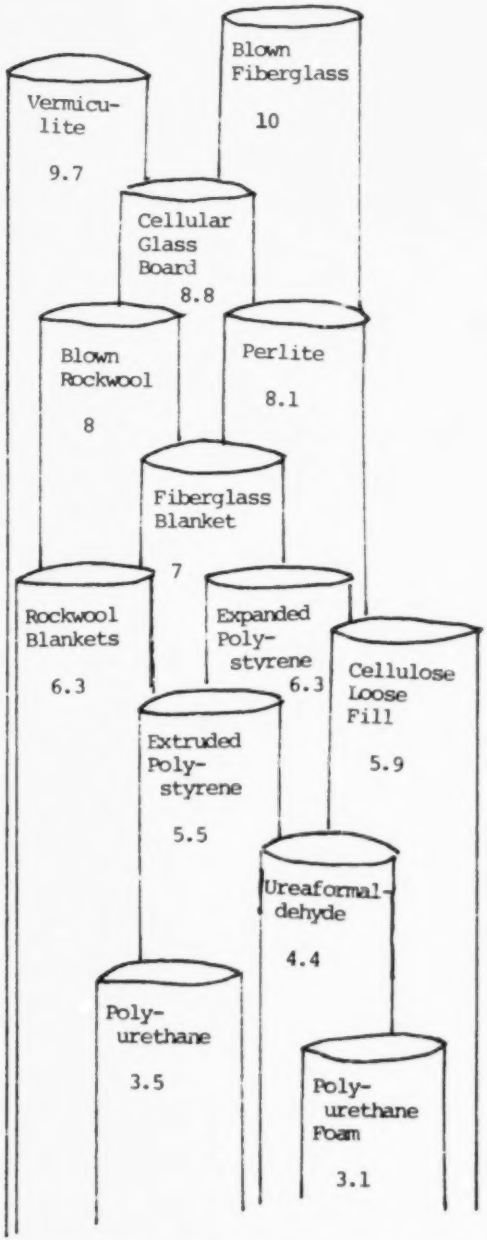
Manufacturers (NAUFIM) feel that their products can easily meet DOE's proposed standard.



Graph shows inches of insulation needed to obtain an "R" value of 22.

A second source of formaldehyde gas emission results from hydrolysis of the polymerized resin in the foam. Mechanisms contributing to resin hydrolysis cannot be quantitatively calculated. Studies performed by the University of Iowa[3] have shown that during periods of high temperature (92°F) and humidity, appreciable amounts of formaldehyde gas may be released over a two to three day period after which negligible amounts of gas are produced. Graphs prepared by the Iowa study show air samples taken from test chambers containing UF foam having formaldehyde concentrations of over 160 ppm for brief periods of time (less than two hours). This figure is somewhat misleading since a proportional amount of formaldehyde released from the foam surrounding the hypothetical room discussed earlier would yield a concentration of 15-20 ppm, assuming uniform mixing. Additional graphs showing long-term (30 day) effects of hydrolysis at low temperatures indicates a maximum of 0.4 ppm could be expected when applied for the hypothetical room.

We argue that the maximum values for formaldehyde gas concentrations tabulated here would be lower for all actual living conditions. Quantitative figures prepared for this paper deliberately neglect factors contributing to lesser concentration values, those being:

a. Air overturn within the room (normally once per hour for a moderately tight space[4]).

b. Venting of gas to the outside of the building through the roof and weep holes.

c. The simultaneous emission of gas within the foam is not possible due to the slow curing process and characteristic hydrolysis only at the dimethylene ether bridge and methyol end group of the resin molecule.

It should also be noted that some shrinkage and decomposition of UF foam can occur during periods of high humidity (100%) and temperatures (+92°F). Linear shrinkage of the foam is of special concern because of the reported high order decrease in insulating efficiency with corresponding

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TABLE II

THIS TABLE SHOWS VARIOUS TYPES OF INSULATION AND HOW THEY COMPARE IN FIRE HAZARD CLASSIFICATIONS. THE COMPARISON IS A NUMERICAL RATIO BASED ON ASTM E84 STANDARDS USING ASBESTOS BOARD AS 0 AND UNTREATED RED OAK AS 100. THESE ARE AVERAGE VALUES AND SPECIAL PRODUCTS MAY VARY SLIGHTLY.

INSULATION TYPE	ASBESTOS	UNTREATED RED OAK	FIBERGLASS	EXPANDABLE POLYSTYRENE 3"	EXPANDABLE POLYSTYRENE 4"	ROCKWOOL	CELLULAR GLASS BOARD "FORMGLASS"	UREA FORMALDEHYDE (FOAM EXPOSED)	URETHANE FOAM	URETHANE BOARD 2"	URETHANE BOARD 3"-4"	BLOWN IN CELLULOSE TREATED
Flame Spread	0	100	Varies but no greater than 25	0	5	Varies but no greater than 25	5	25	25	25	25	25
Fuel Contributed	0	100	50	0	0	50	0	10	15 to 20	5	5	5
Smoke Developed	0	100	50	40 to 100	250 to 350	50	0	5	100 to 500	135	135 to 200	5

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small amounts of shrinkage. Experiments by the Dynatech Research and Development Company show a 5 percent loss in thermal performance for each 1 percent of shrinkage. For this reason, the authors do not recommend the use of UF foam in tropical conditions.

Other factors of material and performance standards of UF foam have not been adequately studied. Documentation of the effect of UF foam on other building materials or alterations resulting from freezing and thawing have not been published.

The authors accept a certain degree of uncertainty while evaluating various tangential problems of UF insulation. In addition, our research has revealed that rigid standards cannot guarantee zero formaldehyde off-gassing. However, Fifth District (ecv) has prepared a specification for UF-foamed in-place insulation which will guarantee that the present known potential for off-gassing is limited to manageable amounts. In addition, the specification guarantees:

a. High quality of components and resulting products.

b. Reliability and professionalism in the installation process.

c. That minimum foam shrinkage occurs.

Copies of these specifications are available upon request from CGD Five (ecv).

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(1) Federal Register, Vol. 44, No. 247, 21 December 1979 (10 CFR, Part 456, pp. 75956–75981).

(2) Walker, J.R., "Formaldehyde," 3rd Ed., Reinhold Pub. Corp., New York (1964) p. 99.

(3) Long, K.R.; Pierson, D.A.; Brennan, S.T.; Frank, C.W.; and Hahne, R.A.; "Problems Associated With the Use of Urea Formaldehyde Foam for Residential Insulation," University of Iowa, Iowa City, Iowa (1979).

(4) Lane, Earl, "Insulated Building May Hold Pollutants," LA Times/Washington Post News Service (February 1980).

About the Authors

After graduating from Temple University in 1975, LTJG D.G. WESTERHOLM, USCGR, worked for Lanchester Corporation in eastern Pennsylvania. Shortly thereafter, he was accepted into Coast Guard Officer Candidate School and graduated in December 1976. He was assigned to the Civil Engineering Branch in the Fifth Coast Guard District where he remained for three years (the last two of which he was involved with energy management). Presently, he is State Liaison Officer for the Fifth District Boating Safety Program.

LTJG W.D. ELEY, USCGR, graduated from the University of North Carolina in 1975. Following graduation, he worked three years as a teacher and chairman of the Science Department at Guy B. Phillips School in Chapel Hill, North Carolina. After finishing Officer Candidate School, LTJG ELEY was commissioned as a Coast Guard Reserve ensign in June 1978. LTJG ELEY served a tour afloat on the Coast Guard Cutter *Taney* before reporting to his present assignment in the Civil Engineering Branch, Fifth Coast Guard District.

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Avionics System Design Requirements for the U.S.C.G. HH-65A Dolphin

CDR D.A. Young
USCG Aircraft Program Office
Grand Prairie, TX

A paper presented to the Sixth European Rotocraft and Powered Life Aircraft Forum, Bristol, United Kingdom, 16-19 September 1980

Abstract

Aerospatiale Helicopter Corporation (AHC) was awarded a contract by the United States Coast Guard for a new Short Range Recovery (SRR) Helicopter on 14 June 1979.

The award was based upon an overall evaluation of performance, cost, and technical suitability. In this last respect, the SRR helicopter was required to meet a wide variety of mission needs for which the integrated avionics system has a high importance.

This paper illustrates the rationale for the avionics system requirements, the system architecture, its capabilities and reliability and its adaptability to a wide variety of military and commercial purposes.

Introduction

The mission of the United States Coast Guard is to protect lives and property at sea. Within this broad scope of responsibility, the new HH-65A helicopters, being procured under a recently awarded contract to Aerospatiale Helicopter Corporation (AHC), will find a variety of applications for a service which prides itself on its adaptability and multimission service to the public. This paper briefly discusses how the HH-65A avionics system requirements relate to these missions, the system architecture, reliability aspects, and specific capabilities.

The most well known activity of the Coast Guard is its search and rescue role. While it may be the most demanding, from the standpoint of equipment, manning, and reliability requirements, our resources must be consistent with several other roles. The majority of Coast Guard forces are spread out quite thinly along the coastline of the United States. Typical tasks include maintenance of fixed and radio aids to navigation (buoys and Loran-C, for example), enforcement of fishing treaties, drug interdiction, ice breaking for domestic shipping and polar operations, safety inspections of ships and oil drilling platforms, prevention and cleanup of oil and other chemical spills, and support of other government and scientific agencies. At the same time we are also, at small added cost, a significant asset in the maritime defense capability of the United States.

Each of these tasks employ helicopters routinely so that each aircraft, like the service, must be a multimission asset. The helicopters must, in addition, be capable of operating in the extremes of meteorological conditions (from tropical to polar areas) and from a wide base of operations (land based stations and from ships). Furthermore, the helicopters mus. be capable of being diverted from one mission to another at a moments notice. The size and weight of the new helicopter was constrained by the types of production helicopters available and the requirement to operate from small ships.

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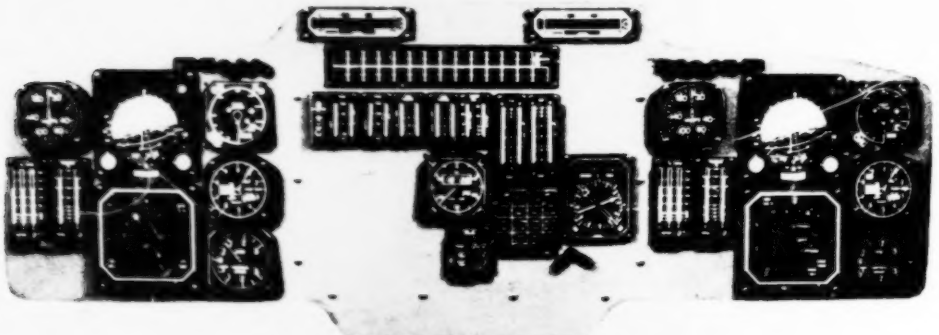

Figure 1. HH-65A instrument panel.

he Avionics Architecture

he development of the Avionics System pecification for the HH-65A helicopter was fluenced by the Coast Guard's desire to educe the intense air crew duties during a earch and rescue flight. Since the visual earch and mission management are best andled by the crew, the routine functions f flight control, navigation, power train anagement and even routine ommunications should be relegated to an utomatic mode as much as possible.

hese desires and the foregoing operational equirements resulted in the following vionics equipment and architecture pecification. Certain equipment are Coast uard furnished to preserve commonality ith standard Navy and Coast Guard ystems. Other systems were specified on a ommercial brand-name-or-equal basis or urely on a functional basis relying on RINC or FAA TSO specifications. It was cognized early in the program that aircraft erformance (including that of its installed vionics equipment) is the important end roduct and that such "flyaway" erformances are the important parameters specify. Therefore, FAA certification is e rule, where applicable, and includes ategory II IFR approach capability, area avigation precision to the standards of FAA dvisory Circular 90-45A, and all of the tendant safety of flight criteria. nvironmental conditions for particular quipment are not specified except that they ust be commensurate with the flight ndition envelope of the aircraft as a hole. The prospective aircraft anufacturers could, therefore, protect equipment from temperature or other environmental extremes or "harden" them if exposed. In fact, a combination of these two procedures was proposed by AHC.

Appendix 1 is a list of the principal avionics systems to be installed. An immediate reaction to this list might be that it would be impossible to accommodate all of the control heads to operate the equipment. The dilemma which faced the Coast Guard is obvious. The requirement for a large suite of avionics equipment with the practical constraints of weight and volume imposes the necessity to use extraordinary means to make all this equipment fit. Yet, the fleet size of 90 helicopters cannot support a large development cost. The Coast Guard also did not wish to equip itself with aircraft or installed equipment which are peculiar to itself and, therefore, difficult to support in later years.

Furthermore, it was recognized that not all equipment is required for all missions. The Coast Guard design philosophy, therefore, was predicated upon the following basis:

FLEXIBILITY—The system must be able to accommodate growth and change (possible additions or replacements would be a microwave landing system, FLIR, or NAVSTAR/GPS receiver). Electronic interfaces must be standardized.

ADAPTABILITY—The system must lend itself to removal of equipment in a snap-on/off manner to adapt to particular missions or bases of operations. For example, it must be possible to remove certain equipment (such as one or more VOR receivers, Loran-C receivers, IFF, Loudhailer, Voice Scrambler, VHF-FM transceiver), depending on their mission utility, to increase payload without changing the cockpit configuration.

In consideration of these factors, the Coast Guard specified a system architecture implemented in a manner which—

1. Provides complete redundancy in all primary and most secondary capacities;
2. Combines all navigation and communication control and displays functions in the Central Control Display Units (CDU's), Horizontal Situation and Video Displays (HSVD's), and HSVD Control Panel—all of which are dual redundant; and
3. Utilizes a MIL-STD-1553B multiplex data bus system to integrate individual components.

The HH-65A Avionics System which resulted from the competitive procurement is a very integrated and adaptable one. From the pilot's point of view, the cockpit panel and console layout (Figure 1) is very clean and compact. The underlying system architecture bears some examination, however, to appreciate its features.

The heart of the system operation is the Flight Management System (FMS). It interconnects and operates with the navigation sensors, the communication radios, the flight guidance equipment, and special sensors such as the radar, power train sensors and air data equipment. Although the HH-65A avionics system is not completely digital, the multiplex data bus system is essential to the light-weight, efficient operation of the FMS. In its most simplistic form, the data bus system can be depicted as shown in Figure 2.

In this case a single multifunction control display unit (CDU) transmits and receives data, on a time-shared basis, through a shielded, twisted pair of wires called a bus. The content and control of this data, generated at a rate of one million bits per second, is managed by the Bus Controller which contains all the bus control logic, memory, and timing circuits. There may be certain equipment, dedicated to communication, navigation, armament or displays which operate directly on the bus. In this case the CDU communicates directly to these equipments to change modes or frequencies. Other data, in turn, is returned to the CDU or Navigation display for readout to the pilot.

The immediate advantage of a multiplex data bus system becomes apparent when one considers all of the wires for tuning, mode control, and analog data which would be otherwise required to be routed throughout the aircraft. This problem compounds itself as additional communication, navigation, sensor and display equipment is added.

Equipment which will connect directly to a multiplex data bus is still rare, and it is necessary to provide the proper interface to existing equipment. As a practical matter, it is easiest to combine interface adapters with the bus controller into one unit (which we call a Systems Coupler Unit or SCU). Figure 3 shows how such a unit is added.

In this case, digital control commands from the CDU are converted into, for example, a typical set of "2 out of 5" tuning discretes plus mode discretes to control a VOR receiver. While the analog VOR data might be reconverted to digital data on the bus, it can be wired directly to any electro-mechanical display which also has no bus interface.

The system as shown is obviously not adequately reliable since a failure of either the CDU, the SCU (or its internal bus

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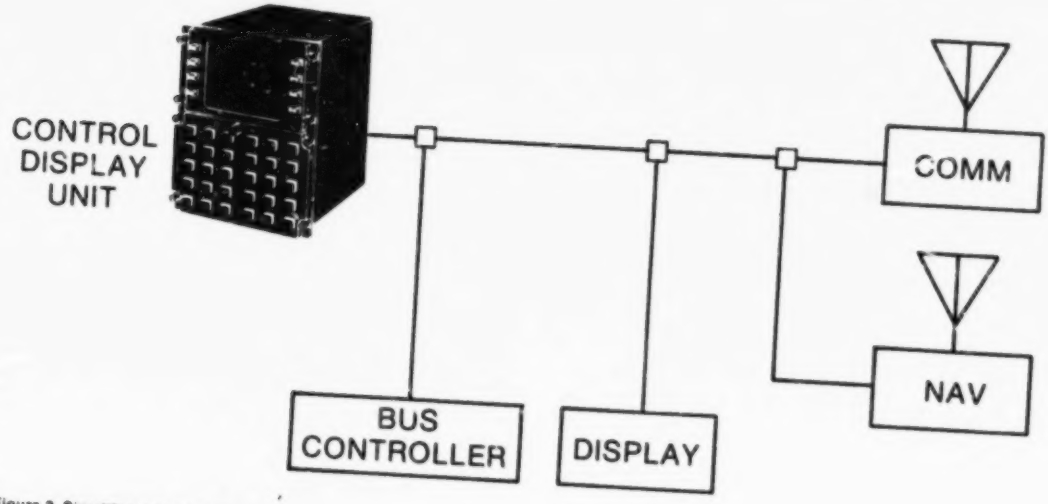

Figure 2. Simplified data bus structure.

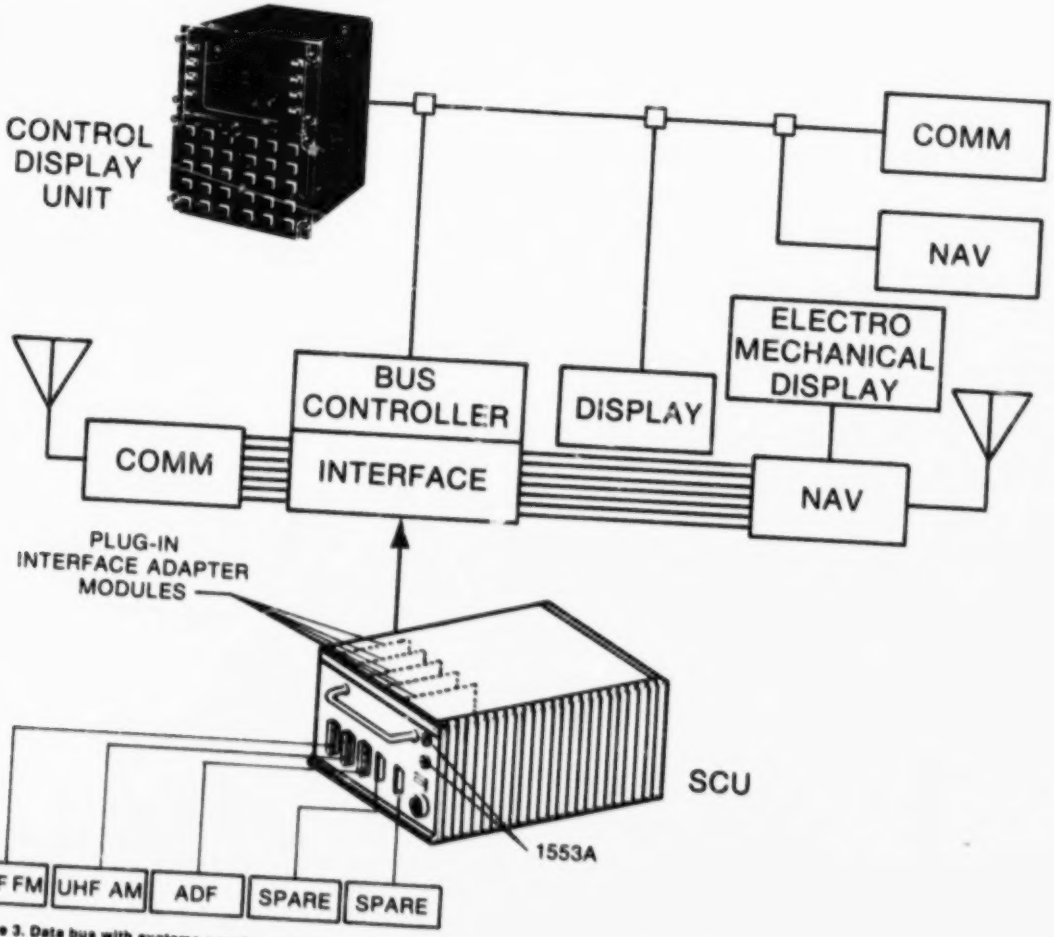

Figure 3. Data bus with systems coupler unit.

controller) or the bus itself would cause a complete failure of the whole avionics system. In addition, the CDU is, at any one time, devoted to one control or display function as is the navigation display. To solve this problem, the system is reconfigured as shown in Figure 4.

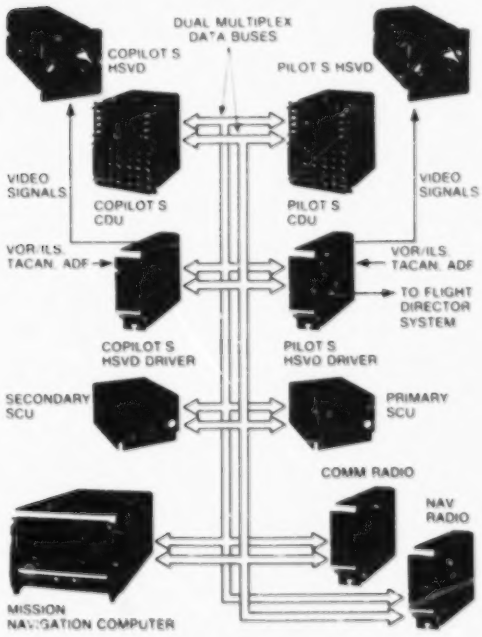

Figure 4. Dual data bus structure.

Another CDU has been added. This allows independent yet redundant control and display of all units. A failure of one CDU does not affect system operation except, for example, that a simultaneous control display of radio frequency and navigation functions is not then possible. The additional parallel data bus, navigation display, and SCU (which includes another bus controller) provide a high mission completion reliability with independent and simultaneous control and display capabilities for two pilots.

A new item, the Mission Computer Unit (MCU) provides specialized services to all other systems on the bus. These services include Loran-C, VOR and TACAN coordinate conversion, through a Kalman filtered position estimator, into geographic coordinates, RNAV flight plan management (including generation of search patterns), engine and power train condition monitoring and recording, and performance and fuel alert calculations. In addition, the MCU retains a data base consisting of navigation waypoints, listings of local rescue resources, and engine trend data.

This, then, describes the architecture of what the Coast Guard terms a Flight Management System (FMS). Figure 5 is the face of the CDU showing one typical function, communication radio control, in use.

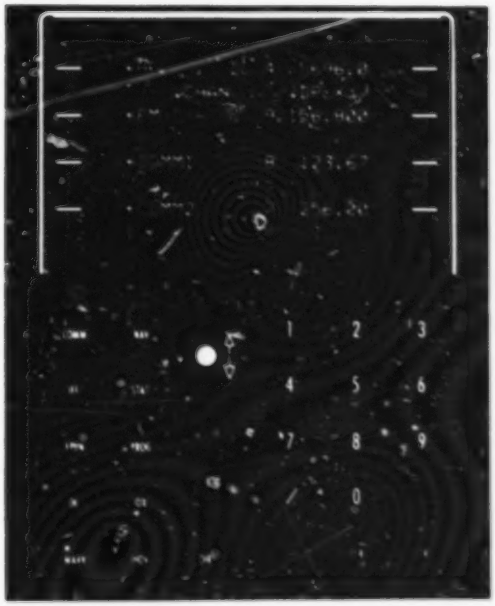

Figure 5. Flight Management System CDU.

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Automatic Flight Control System

The pilot's effectiveness is much higher when not concerned with the helicopter's stability, especially in a low altitude hover at night. The HH-65A Automatic Flight Control System (AFCS) provides hands-off attitude and heading retention, stability/command augmentation for manual flight, automatic trim in all axes, and full coupling to the navigation systems through the flight director. The entire mission can, in fact, be flown automatically through the various flight director modes.

The AFCS uses a combination of limited authority series servos (for high frequency stability augmentation) and full authority parallel servos (for trim and "outer loop" guidance functions). To meet Coast Guard requirements for safety, the AFCS is fail-passive: Whenever a failure occurs, it causes (1) no perceivable control motion and (2) positive disengagement and alerting of the pilot. To meet our requirements for mission reliability, each AFCS axis engages individually to permit continued operation of the nonfailed axes.

Flight Director System

The navigation equipment (mission computer, VOR and TACAN) provide flight guidance information to the AFCS through the Flight Director System (FDS). The FDS accepts these inputs and computes pitch, roll, and collective steering commands according to the selected mode, as shown in the following table.

FLIGHT DIRECTOR MODES

HDG SEL	Heading Select
NAV	Navigation (VOR/LOC/BC/RNAV/TACAN)
APPR	Approach (VOR/ILS/BC/RNAV/TACAN)
IAS	Airspeed Hold/Beep
VS	Vertical Speed Hold
ALT	Baro-Altitude Hold
IAS/VS	Airspeed and Vertical Speed Hold (Pitch and Collective)
HOV AUG	Hover Stability Augmentation (Accelerometer Input to Coupled Mode)
T-HOV	Transition to Hover
GA	Go-Around/Auto-Takeoff

These commands are provided to the AFCS for coupled operation and, in addition, they are displayed on the Attitude Director Indicators (ADI's), shown in Figure 6. If any or all of the AFCS axes fail to operate, the pilot may revert to manual flight using these displayed steering commands with little additional workload. This is a reversionary procedure which contributes to mission reliability.

Figure 6. Altitude director indicator.

The most interesting of these flight director modes is the "T-HOV" or Transition to Hover mode. The pilot selects the Approach (APPR) mode to fly an ILS or RNAV approach in a fairly typical fashion. The FDS provides cyclic and collective commands to capture and follow the approach path at an approach speed which can be modified throughout the approach. "Armed" while in the APPR mode, the T-HOV mode "captures" at 100 feet radio altitude and commands a deceleration to approximately zero groundspeed at 50 feet above the surface of the runway or water. Figure 7 is a profile of the T-HOV mode of approach.

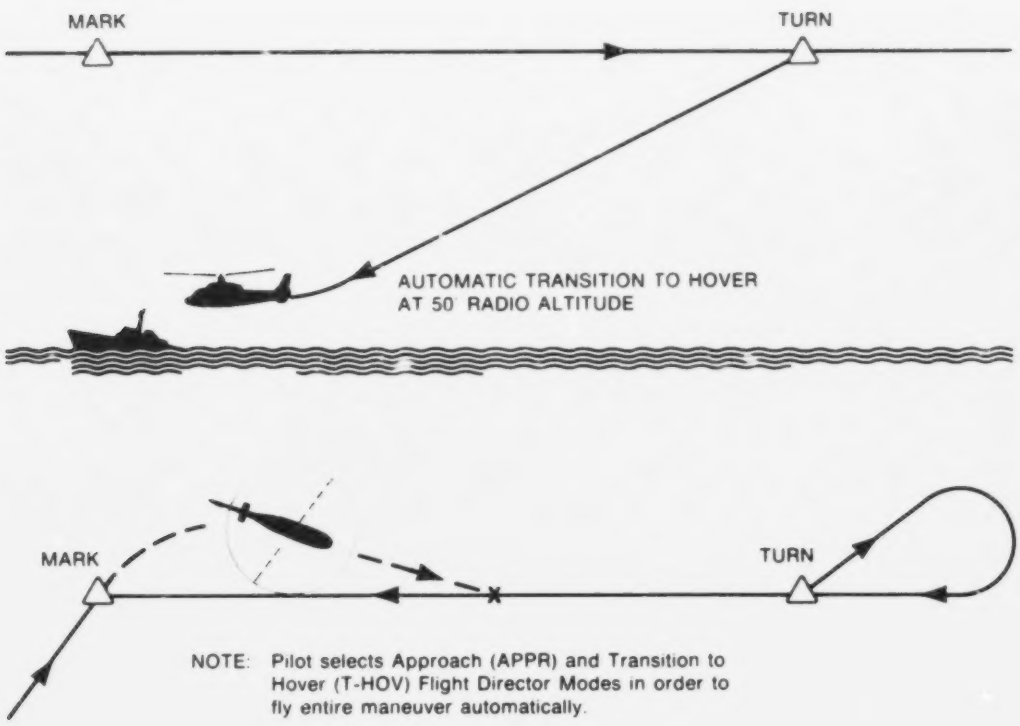

Figure 7. Transition to hover profile.

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Special Systems

The HH-65A will incorporate other equipment which, while not technically new in military systems, is integrated into this system in a unique way.

The aircraft's power train instruments are vertical, electro-optical instruments which are commercial versions of those which are installed in the Army Blackhawk (UTTAS), Navy Seahawk (LAMPS) and Army Advanced Attack Helicopters. The Coast Guard specified an Engine Condition Monitoring System (ECMS) which uses power train data already available in digital form in the instrumentation system and analyzes that data in the computer already existing on the aircraft. The ECMS continually monitors the engine and power train for trends, exceedances, power availability checks; it monitors fuel quantity and alerts the crew when the amount remaining is sufficient only to fly direct to the destination from the helicopters present position, plus reserve. It computes maximum range airspeeds for the current wind and the available power reserve prior to hovering. The ECMS is actually a "function" of equipment already on the helicopter—it is available at no extra cost in weight or additional hardware.

The radar is an adaptation of the Bendix RDR 1300 helicopter radar. The radar antenna has been specified to be larger for higher resolution and detection capability and it employs a digital video integrator to help decorrelate sea return clutter. The actual display of the radar is accomplished on the Horizontal Situation and Video Display (HSVD).

The requirement to display multiple navigation sensor information, flight plan data, and search sensor video, along with a need to keep the instrument panel as small as possible for search visibility, resulted in the specification for a HSVD. This CRT device supplies the navigation and tactical situation and sensor data needed by the crew for each mission phase. Seven display modes and three navigation and sources are independently available to each pilot. The display modes include not only a conventional HSI format, but radar, map, and a special hover display which is useful for low altitude, low airspeed, close-in navigation to a spot. It is this hover display which is used to present low range, omnidirectional airspeed from the Pacer LORAS to the pilots.

Provisions for the display of Forward Looking Infra-Red (FLIR) video have been provided so that this equipment can be added to the helicopter in the near future with a minimum of retrofit difficulty. The combined radar-map display, Figure 8, is representative of the flexibility this device has.

Figure 8. HSVD Radar-map mode.

Certification

The Coast Guard will depend upon the FAA certification process as an acceptance criteria for the aircraft and the avionics system. This means that except for certain military items (such as the TACAN, voice scrambler) all equipment must meet FAA TSO's and must be installed and certified under the aircraft's Type Certification (TC) or a Supplementary Type Certification (STC).

Although the HH-65A avionics system is a synergistically integrated set of individual subsystems, these multiple subsystems will be individually STC'd. With a system such as this, there is a built-in flexibility which will allow other users to select from a large menu of qualified new products depending on their specific requirements. The operator must only determine what capabilities he requires: single or dual pilot IFR operation, area navigation, special instrument approaches, two or three cue flight director, collective assist in the AFCS . . . and most of this adaption is possible with little apparent change in the cockpit. In fact a fleet of differently equipped helicopters can retain the same cockpit configuration—even as new systems, such as satellite navigation and microwave landing systems, are introduced.

The HH-65A will become operational in the spring of 1982. The Coast Guard has specified a helicopter and an avionics system which is planned to have a long service life. From all appearances, these expectations will be fulfilled, despite changes in missions and technology, for many years.

Appendix 1. Installed Equipment List.

COMMUNICATIONS:	
HF Transceiver, 2-30 MHz	Collins 718U-5
VHF/UHF Transceiver	ARC-182 (dual)
VHF-FM Transceiver	Wulfsburg RT-9600
Transponder	APX-100
Voice Scrambler	VP-II
Public Address System	AEM 400
Emergency Locator Transmitter	CIR-11
Acoustic Beacon	Dukane N15F210B
Intercomm System	Pilot, Copilot, Crewmembers
NAVIGATION:	
VOR/ILS/MB	ARN-123 (dual)
TACAN	ARN-118
LF-ADF	COLLINS DF-60
VHF/UHF ADF	COLLINS DF-301
LORAN-C	NSI ADL-82 (dual)
Radar Altimeter	HONEYWELL HG-7502
Air Data	PACER LORAS-1000
FLIGHT GUIDANCE:	
Flight Director	Collins HFCS-800
AFCS	Collins HFCS-800
DETECTION:	
Radar	BENDIX RDR-1300 derivative
FLIR	Display provisions
INSTRUMENTATION AND DISPLAYS:	
ADI	3 cue (dual)
HSI	Collins MFD-80 multifunction display system
BDI	Collins BDI-36
Engine Instruments	Canadian Marconi 730 series vertical-scale electro-optical
Various Others	As required for FAR 29, dual pilot instrument flight
COMPUTER:	
Navigation, LORAN-C coordinate conversion, waypoint memory, engine condition monitoring, fuel alert, mission computer, data link	Collins CAPS-5

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About the Author

Commander David YOUNG is a 1963 graduate of the United States Coast Guard Academy. After sea duty on the USCGC *Blackthorn*, he completed flight training and served as a search and rescue pilot at Traverse City, Michigan. He acquired his masters degree in electronics engineering in 1971 and has since served as chief of the aircraft prototype and technical services branch at the Aircraft Repair and Supply Center at Elizabeth City, North Carolina. During a tour at Coast Guard Hoadquarters, he managed several remote sensing projects and participated in the HH-65A procurement. He is presently the Commanding Officer of the United States Coast Guard Aircraft Program Office, resident at the Aerospatiale plant. Commander YOUNG is a member of the IEEE and AHS.

The Semantics of Quality

CAPT W. M. Devlin
Quality Assurance Division
U.S. Coast Guard Headquarters

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Quality, motherhood, and apple pie have several things in common. We're all for them, they're all "good," and we all think we understand them. But do we?

In inverse order, apple pie is somewhat standard. It can be sweet or tart, the crust can be flakey or doughy, but there is very little confusion as to what is meant by the terms. The semantics are straightforward.

Motherhood is similarly well defined.

Quality, on the other hand has semantic problems. In the admittedly unabridged version of the Random House Dictionary of the English Language, fifteen definitions of the word are given.

Small wonder then that the professionals in the "Quality" field have seen fit to generate a standard, ANSI/ASQC A3-1978 Quality Systems Terminology, just so they can communicate in the technical, contractual, and legal world in which we live.

I would like to address some of that terminology and relate it to the Coast Guard Quality Assurance Program.

Quality

"The totality of features and characteristics of a product or service that bear on its ability to satisfy given needs."

In order to be able to assure, control or improve quality, it is necessary to be able to evaluate it. This definition calls for the identification of those characteristics and features bearing upon the "fitness-for-use" of a product or service. The "ability to satisfy given needs" reflects value to the customer and includes economics as well as safety, availability, maintainability, reliability, design, and all other characteristics that the need for the product or service involves. The phrase "given needs" includes defining a price as well as stating what must be achieved, since it is usually possible to improve use characteristics if price is not a limitation. Specifications for the manufacture of a product or the delivery of a service are a translation of these features and characteristics into manufacturing or performance terms.

Quality Control

"The operational techniques and the activities which sustain a quality of product or service that will satisfy given needs; also the use of such techniques and activities."

The aim of quality control is to provide quality that is satisfactory (e.g., safe, adequate, dependable, and economical). The overall system involves integrating the quality aspects of several related steps including: the proper *specification* of what is wanted; *design* of the product or service to meet the requirements; *production* or *installation* to meet the full intent of the specifications; *inspection* to determine whether the resulting product or service conforms to the applicable specification; and *review of usage* to provide for revision of specifications. Effective utilization of these technologies and activities is an essential element in the economic control of quality.

This definition lets us pose an interesting question: "Who in the Coast Guard is involved in Quality Control?"

The answer is: "All of us." If you don't find yourself in the picture, you'd better look again. Every single element of the Coast

Guard can be found in that definition. If you think you've found an element that can't, better consider abolishing it.

Quality Assurance

"All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given needs."

Quality assurance involves making sure that quality is what it should be. This includes a continuing evaluation of adequacy and effectiveness with a view to having timely corrective measures and feedback initiated where necessary. For a specific product or service, quality assurance involves the necessary plans and actions to provide confidence through verifications, audits, and the evaluation of the quality factors that affect the adequacy of the design for intended applications, specifications, production, installation, inspection, and use of the product or service. Providing assurance may involve producing evidence.

A shorter answer might well be that Quality Assurance is "The Quality Control of Quality Control."

The Coast Guard's formal Quality Assurance Program, COMDTINST 5210.8, is in reality an *incoming* quality assurance program. It is an adjunct to the procurement process. Since both in-house specification and design review are involved as well as vendor production and inspection, the Quality Assurance definition of "QC of QC" is apt.

Our program "Bibles" are the specifications development guide, a soon to be published inspection guide, and various military and commercial specifications. Contrary to popular wisdom, the latter two are remarkably similar. Quality is a universal language.

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Management and Industrial Engineering in the Coast Guard

CDR J. H. Donahue
Office of Engineering
U.S. Coast Guard Headquarters

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Introduction

The Management and Industrial Engineering Program in the Coast Guard is small and virtually unknown outside its "fraternity" of officers. This article is intended to shed some light on the current program and encourage engineering and science/mathematics graduates to consider this field when deciding upon a specialty.

Mission

Operating units require maintenance organizations that are responsive to their needs, and over the years, Industrial Bases have provided this response. Their mission simply stated is to—

a. Provide maintenance and repair services effectively and efficiently to the operating units;

b. Be reliable and responsive; and

c. Provide the best return on the Coast Guard investment dollar.

Probably the most effective use of the Industrial Activities is in response to emergencies and Coast Guard's peculiar work. The "customer" enjoys the luxury of having an intermediate or depot-level maintenance facility that can provide anytime, day or night, responses to casualties.

Existing Facilities

Presently there are 7 Account 19 Industrial Activities with a combined complement of 406 billets/positions. Table 1 is a listing of the Industrial Management Billets. Although their work has been primarily dependent upon District Engineering financing, over the past five years operational Commanders have been "buying" industrial support. In fact, OG-30 work orders now account for about *half* of the total work performed at the Industrial Bases. They provide district-wide, intermediate and limited depot level maintenance support and are an attractive alternative to "contracting out" for maintenance and construction services. They also provide the support and operational managers with a versatile work force that is not duplicated by the smaller Engineering Support Activities, Assist Teams, ANT Teams, MAT Teams, or Group Engineering maintenance personnel.

Industrial Accounting

Unique to the Coast Guard is Industrial Accounting. The Industrial Management Guide (CG-361) describes the principles, policies, and procedures used in managing the 7 Account 19 Industrial Activities in the service. Volume I of the Comptroller Manual (CG-264) provides the procedures used. Account 19 requires the organization to be fully self-supporting. This entails budgeting annually and charging the customers the full cost of doing business. The Work Order System, as established in the Industrial Management Guide, is used. All costs are accounted for, and an overhead rate is determined that recoups the costs of: industrial plant maintenance, leave and holidays, idle and nonproductive labor, supervision, fringe benefits, travel, and utilities. These costs of doing business are passed along to the customer much the same as a contractor would charge if doing the work.

The Industrial Manager

The Industrial Manager runs the organization. This is a challenging assignment that includes scheduling the workload, minimizing idle time, effectively

managing a sizable work force, and preparing the budget. The Industrial Manager is given these responsibilities early in his or her career, generally following postgraduate training. In fact, of all the engineering disciplines, Industrial Engineering probably offers the most responsibility to any junior officer. How many Lieutenants, for example, are given a management assignment right out of graduate school that may include supervision of 50 military/civilian billets, an annual budget in excess of a million dollars, and a capital plant worth at least that much? Most industrial assignments offer this challenge! The Industrial Manager will have the opportunity to work directly with: the District Chief, Engineering Division; the Engineering Branch Chiefs; the Commanding Officers of vessels; the Commanding Officers of shore units; Group Commanders; and Officers-in-Charge to provide the support needed throughout the district. Professionally the Industrial Manager must be a commissioned officer with a college degree in engineering or science/mathematics. He or she will generally have a graduate degree in Industrial Engineering or Business Administration—with an emphasis in management. Most Industrial Managers have had previous experience in engineering afloat or may have had an exposure to industrial work, perhaps as an Assistant Industrial Manager at a large SUPRTCEN or Base.

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Postgraduate Training

The postgraduate programs at Rensselaer Polytechnic Institute, Troy, NY, and at Purdue University, West Lafayette, Indiana, have provided the academic training needed for our Industrial Managers. A Master of Business Administration degree is granted following a one year, full-time program in the School of Management at Rensselaer. A Master of Science in Industrial Engineering is offered at Purdue. One billet is assigned annually by Headquarters to the postgraduate program.

Both schools accept qualified candidates with undergraduate work in engineering, the physical sciences, or mathematics. Generally, only students in the top quarter of their graduating classes are considered for acceptance. Certain latitude is given the graduate students to select courses that will benefit them in their endeavors following graduation. Both universities have excellent programs and are nationally recognized. The training and advanced degree from either Rensselaer or Purdue will be an asset that can be used throughout a Coast Guard career. Consult Chapter 3 of the Personnel Manual (CG-207) for eligibility and application procedures.

Career Pattern

The Management and Industrial Engineering Program requires the assignment of Industrial Manager coded billets at the eight facilities shown in Table 1. Rotational assignments are available, upon request, approximately 40 percent of an Industrial Manager's career. Assignments such as Engineering Afloat, serving within the Office of Engineering at Headquarters or other shore billets located at district offices, Support Centers or Bases may be available.

You are encouraged to keep your Officer Assignment Data Card current and keep in contact with your assignment officer to see what billets may be opening.

Conclusion

Industrial Management in the Coast Guard is a challenging career! Assignments provide responsibility to senior and junior officers alike. The education, leadership, and experiences gained are very meaningful to the Industrial Manager. Officers looking for an engineering specialty should consider the Management and Industrial Engineering program.

About the Author

CDR James H. DONAHUE is the Senior Staff Assistant, Office of Engineering, USCG Headquarters. He was formerly the Chief, Public Works Division at Support Center Kodiak, Alaska. He received a Bachelor of Science Degree in Civil Engineering at the University of Massachusetts and a Master of Civil Engineering at Old Dominion University. Previously he has been assigned to the

Civil Engineering Branches of the First and Fifth CG Districts. He was also Public Works Officer at the CG Aviation Training Center, Mobile, AL, and has served aboard the CGC *Kukui*. He is a registered professional engineer in the Commonwealth of Virginia.

Table 1—Management and Industrial Engineering Billets

Billet	Location	Desired Experience	Desired Education
CDR	SUPRTCEN New York	Assistant Industrial Mgr. or Industrial Mgr. at Smaller Activity	Postgraduate
LCDR	SUPRTCEN Boston	None, although Assistant Industrial Mgr. at Smaller Facility is desirable	Postgraduate
LCDR	SUPRTCEN Portsmouth	None	Postgraduate
LCDR	BASE Miami Beach	None	Postgraduate
LT	BASE New Orleans	None	Postgraduate desired. Undergraduate Engineering or Science/Math
LT	SUPRTCEN New York	None	Postgraduate desired. Undergraduate Engineering or Science/Math
LT	BASE Honolulu	None	Postgraduate desired. Undergraduate Engineering or Science/Math
LT	* BASE Terminal Island	None	Postgraduate desired. Undergraduate Engineering or Science/Math
LT	* BASE Milwaukee	None	Undergraduate Engineering or Science/Math

* Not on Industrial Accounting

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Helical Strake Kit to Reduce Flow-Induced Vibration of Single Pile Aids to Navigation

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Summary

This paper describes a helical strake used on a single pile aid to navigation in San Pablo Bay, California; in this environment, currents in excess of 6 knots with water depths of 40 feet had caused single piles to vibrate violently. Vibration measurements after addition of the strake showed little vibration remaining.

Introduction

In San Pablo Bay, California (near San Francisco), several aids to navigation single pile structures in high current areas were exhibiting large vibrations. Vibrations severe enough to destroy the entire structure were reported. In an attempt to alleviate this problem, the U.S. Coast Guard tested a new product known as "STARSTRAKE™" which was developed by Fathom Oceanology Limited of Port Credit, Ontario, Canada.

Background

In the summer of 1976, eight single pile steel structures were established in San Pablo Bay. These piles (Figure 1) were 16- or 18-inch diameter steel pipe in lengths of 90 to 120 feet. Water depths ranged from 32 to 42 feet; seasonal water flows and tidal currents peaking at 6 knots are common in this area. As a result of these currents, vibrations resulting from vortex shedding phenomena made the platform unusable for mounting the batteries and signal light. These vibrations ultimately caused complete structure failure. Structural failure was not a result of improper embedment.

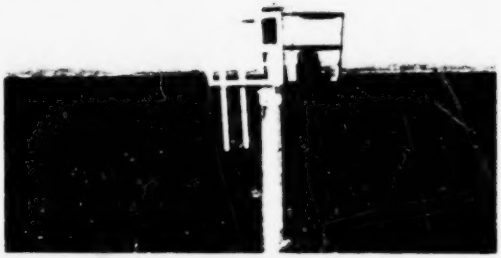

Figure 1. Typical single pile structures.

Circumstances present in this case with respect to the diameter of the pile, the water column exposed to the pile, and the current impinged on the pile indicated possible existence of turbulent flow and vortex shedding. Analysis of the natural frequency of the system and the frequency at which the vortices were being shed at the typical currents indicated that they were the same frequency. With the vortices in synchronization with the natural frequency of the system, the pile was reaching resonance.

Two options were available to solve this problem—modification of the natural frequency of the system or a change in the vortex pattern.

The easiest solution in modifying the natural frequency of the system was to replace the present single pile structure with a multiple pile battered dolphin or a platform type

structure. However, economic considerations indicated that a simple modification to the existing structure to eliminate the vibrating should be sought. Another method of changing the natural frequency is to increase the mass of the pile by grouting it with sand or concrete. However, grouting of the pile would not shift the natural frequency of the system significantly enough to move it out of the range of the vortex shedding frequency. Thus, it was determined that grouting would have a negligible effect on the motion.

It appeared that the best potential for correcting the problem was to use a mechanical device on the pile to reduce the effects of the motion caused by the vortices. A splitter plate was investigated, but was considered ineffective due to the changing directions of the current. It was decided that an omnidirectional device was needed to change the vortex pattern.

Recently, similar failures of tubular structures subjected to surrounding water flow have been reported. The "Oscillation of Piles in Marine Structures, a Description of the Full-Scale Experiments at Immingham," Technical Note 40, published by CIRIA (London, U.K.) is probably the most complete account of the vortex shedding problem available. This report documents a very careful and thorough investigation of the vortex shedding problem on pipes of a similar size. Calculations based upon the "Immingham Report" show that the conditions experienced on the San Pablo Bay structures would cause a peak in vibration "in-line" with the flow at 2.95 knots, and a peak transverse vibration (across flow) at 5.9 knots. In practice, a complex relationship between in-line and transverse vibration would result in an orbital pattern which would change its character as the tidal flow values changed.

A report entitled "Preventing Wind-Induced Oscillations of Structures of Circular Section" by D. E. Walsh published by the Institution of Civil Engineers (London, U.K.) documented the successful use of helical strakes on circular chimney stacks in high winds. Fathom Oceanology theorized that similar helical strakes would be successful in marine applications for vortex shedding vibrations, provided that stresses due to drag were noncritical. According to calculations, the load due to drag (assuming no vibration) is 2514 pounds at 6 knots and would be increased to only 2893 pounds using strakes by the method proposed. This causes a 20 percent increase in stress at the mudline. This increase does not place the total stress in the pile above the allowable stress. Therefore, it was concluded that the increase in drag due to the use of helical strakes was not critical.

To adapt this theory to a marine application, Fathom Oceanology developed a very unique, yet cost effective product known as "STARSTRAKE." As shown in Figure 2, it is a 3-point star section of semi-rigid P.V.C. threaded on a tensioning cable. The STARSTRAKE is wrapped around a pipe to form a triple helix having a pitch of five diameters. The strakes thus formed had a height of one-tenth of the tube diameter. This design is based on the theory that the strakes will change the two-dimensional flow patterns into three-dimensional flow and thus eliminate vortex shedding vibrations.

Testing

As shown in Figure 3, the helical strake design was mounted on a 17-foot long, 20-inch diameter steel pipe which was slid over the 18-inch diameter steel pile like a sleeve. Both ends of the sleeve were fitted with handling lugs welded to the inside wall surface so that they also acted as spacers for concentricity over the 18-inch OD pile structure. It was hung with cables from the top of the structure with the top of the sleeve just below Mean Low Water.

San Pablo Bay light no. 9 was chosen to be the experimental structure equipped with the helical strake kit. The platform on this structure was instrumented with two linear accelerometers. They were mounted at right angles on the horizontal plane and hooked up to two strip chart recorders to read the "x" and "y" directional accelerations as caused by water disturbance. The output of the accelerometer recordings measured the transverse and the in-line vibrations

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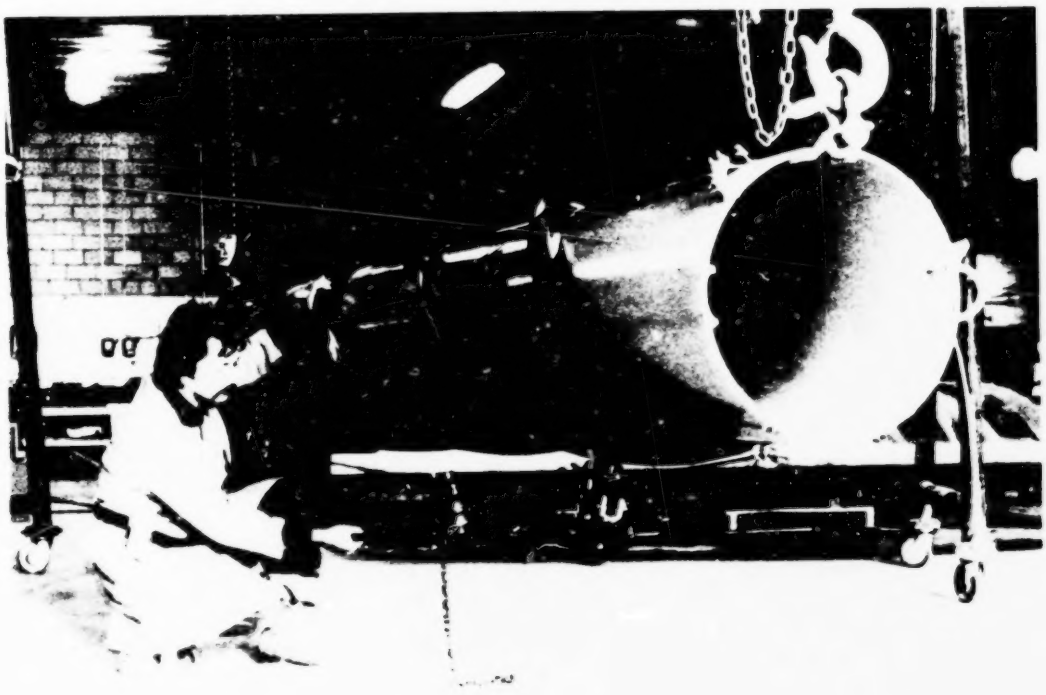

Figure 2 STARSTRAKE

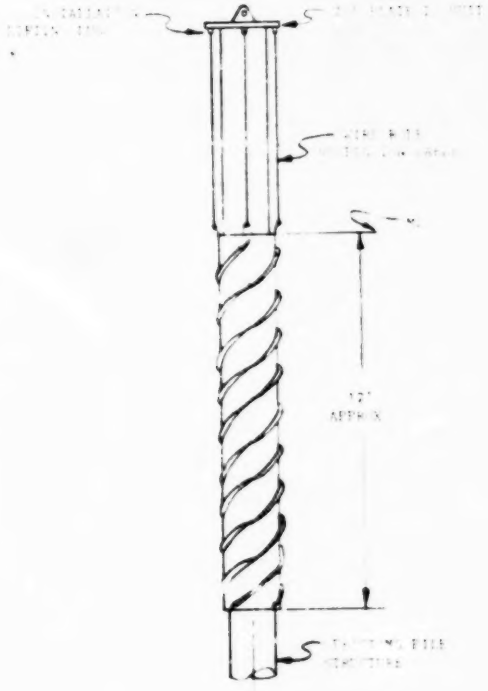

Figure 3 The helical strake design mounted on a steel pile.

separately. This arrangement did not allow an aggregate of transverse and in-line motions to be obtained.

Attempts to obtain vibration measurements of the structure prior to the scheduled deployment of the STARSTRAKE were aborted due to rough weather. Prior to the STARSTRAKE installation, deflections of as much as 2 feet were reported.

The STARSTRAKE was deployed on 12 July 1978 with relative ease. On 18 August 1978 strong currents and light wind prevailed, which permitted the recording of current-induced vibrations. Vibrations due to water flow were minute when compared with vibrations due to wave slap. The calculated amplitude of deflection based on average accelerations of ±0.02g due to water flow was about ±0.25 inches at platform. The frequency of vibration due to flow was about 0.8 Hz at all flows, up to the maximum of 4½ knots. Additional measurements were taken on 26 February 1979 with currents peaking at 6 knots. Accelerations of the same magnitude as the August readings were recorded.

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Conclusions

Over a two and a half year period each of eight structures in San Pablo Bay vibrated to failure at least once. A large number of discrepancies were reported on each of these structures because of severe vibrations shaking loose the power cables, and structure platforms and throwing off the batteries. On-site difficulties precluded the possibility of obtaining measured "before and after" comparisons. However, visual observations during these tests indicated noticeable oscillations of the unmodified structures (described as "flopping back and forth 2- to 3-feet"). At this writing, San Pablo Bay light no. 9 has been operating normally, without any discrepancies as a result of vibrations.

The sensitivity of the instrumentation to pick up the wave slap of passing vessels lends credibility to the minuteness of the flow-induced vibration readings of accelerations and amplitudes. The fact that the frequency of vibration was approximately constant at all flow speeds indicates that there was no vortex shedding influence at all.

It is concluded that the helical strakes in the form of the "STARSTRAKE" has eliminated vortex shedding and has stabilized the structure over a wide band of flow speeds. It confirms therefore, that the concept and effectiveness of the strake technique which has been used successfully on many circular structures to suppress wind-induced oscillations, is equally applicable to the water medium.

About the Author

Mr. Stanley D. Walker graduated from the University of Maryland in 1974 with a Bachelor of Science Degree in Civil Engineering. He started with the Coast Guard in 1971 as a student trainee. Upon graduation, Mr. Walker became a project engineer in the Buoy and Structures Section of the Ocean Engineering Division at Headquarters.

So You're Going To Be A Student Engineer . . . .

Ira Sandpeep
U.S. Coast Guard Academy
New London, CT

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Whether you're from OCS or right out of the Coast Guard Academy, assignment as a student engineer conjures up several questions.

Naturally, the more you've been associated with the service the more familiar you are with the program and how good it is. Conversely, if at age 22 you're still not sure which is the male thread and which is the female thread . . . you're probably a little concerned about your new assignment.

Admittedly, it can happen that with NO engineering background at all you've managed to wrangle a set of orders with your NAME, a HULL NUMBER and the words STUDENT ENGINEER all in neat little letters. What luck! I say what luck because to be a successful student engineer the only things you need are those orders and some ENTHUSIASM. However, realizing those brief, simple words may not be sufficiently comforting, I have written a GENERAL overview of what-to-expect as-a-student-engineer. This article touches briefly on:

- REPORTING ABOARD
- INITIAL DAYS
- PART A
- PART B
- DIVISION OFFICER
- OTHER THINGS

Reporting Aboard

Your EO will be one of two types: (1) prepared for you or, (2) unprepared for you. If your EO says,

"Oh you're here?! Well, err . . . what's your name? Yes, of course, and when do you think you'll get started? Hmmmmm, I wonder if 'they' have any Part A forms in the log office?"

This EO is unprepared. Now, there may be many reasons why the EO isn't ready. He may be a little overwhelmed himself. In any case, this only means you will have to be a self starter.

If your EO says,

"Hello (*your name*), I saw your orders some time ago, hope you got my letter. Our schedule *is* busy but do take time to get your family settled in. We'll be away long enough in a few months. I've got Chief GODFATHER lined up to take you under his wing. We'll talk about what I expect and your collateral duties in a few days."

Consider yourself fortunate. This fellow is prepared.

Initial Days

Naturally, you'll be introduced around. Some will like you, some won't, and some won't care. Life is like that, don't let it hurt your feelings.

When the Wardroom Warrants start chanting, "NEWBOOT, NEWBOOT . . .", expect it, it has something to do with their

coffee; I call it cyclamate poisoning. However, if after a few months, WO4 FIREBREATHER doesn't calm down, sit next to him at lunch, calmly pour the soup-de-jour on his lap and say, "Only a BOOT wets his pants, John." He'll know you've come of age then.

Your early days will be busy. Chief GODFATHER will be there to get you started in the right direction. Which is:

INPORT—observe ongoing work
ask lots of questions
stand inport duty
work on PART A
memorize the student engineer's oath
AT SEA—the same, except stand at sea watches

Part A

It is important in Part A that you NOT BE shy. Ask questions. Pitch in where needed. It is not necessary to know everything about *anything*. No one expects you to be an experienced engineer (or experienced officer). For heaven's sake, note the word *student* engineer.

Part A is the opportunity for hands-on experience. If pumps/clutches/ pistons/ boilers and heat exchangers are objects in which you've always been interested, but thought you could never understand, then this is the program for you. The entire program is defined in the Personnel Manual, article 3-F-17. The Commanding Officer is directed by the COMMANDANT to personally ensure the program is carried out. The EO shall "actively supervise and instruct the student," and Chief GODFATHER intuitively knows the early emphasis must be on practical work.

Oftentimes, you'll wish you knew as much as the Chief. *Relax*, and accept the fact that experience is a teacher that can't be rushed.

After several months of intensive line tracing, bilge diving and watch standing, your shining moment will come when GODFATHER is discussing a seldom used cross-connect valve on some obscure system. Here, you proudly announce that the valve is under the after deck plate, is useable, but presently has no handle on it. Your self esteem hits new heights as the Chief grumbles, "Good job."

Student Engineer Oath

An important training aid for all students is the careful placing of masking tape across the stateroom mirror. Then, in 1 inch block lettering, the placing of these words on that mirror:

KEEP EYES/EARS OPEN . . . KEEP MOUTH SHUT! (EXCEPT TO ASK QUESTIONS!)

This is the student engineer oath and should be repeated often. I say often because, as a young officer, it's tremendously easy to make rash judgements, especially in dealing with crewmembers. Don't let your eagerness to "right the world" rush you towards inserting both feet in mouth, then backtracking rapidly while putting out the fire on the seat of your pants.

When dealing with people, proceed with caution. This brings us to some rules.

THE STUDENT ENGINEER's EARLY RULES:

1. Let the CHIEF and PETTY OFFICERS handle their own situations. You should observe and listen. DON'T jump in! Something you consider perfectly straightforward can have more facets than a 2 carat diamond ring.

2. If *you* must make a decision, get some advice before doing so!

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Part B

PART B is a plateau of sorts. Life changes. PART B will emphasize practical experience, watchstanding and administrative work. Here, you will qualify as an at-sea Engineer Officer of the Watch. One night Chief GODFATHER will say, "You take the watch; I'll be in the log office if needed," and he'll actually walk off! Wow! Your first you-got-it watch! Unbeknownst to you, Chief and EO are in the log office and it's no coincidence that MK1 GOODMAN 'happens' to be on watch with you. Every little noise/whirr/buzz and drip will be processed and catalogued by you for the next four hours. That one odd noise you can't quite place is your heart pounding.

In PART B, you'll be reading about the administration and supervision of the engineering department. Carefully read the ADMINISTRATION guideline on page 3-F-19; it arms you with the questions to which you'll want answers. Remember, the EO has a lot of things to keep tabs on and it's important for you to learn how he does it and why. The EO does not turn wrenches; he administers the Engineering Department. Someday you might too.

Division Officer

During Part B your assignment as division officer, usually as Electrical Assistant or Auxiliary Assistant, will most likely occur. Division Officer is a tough role. Inexperience with enlisted personnel and inexperience with a supervisor's role can present some difficulties.

Let's assume the worst situation. You've inherited Chief SNAPDECISION and PO2 DRINKINGBUDDY. They like to run things their way. Fine. *You* can't direct anything until you know which way *you* should be going. If that takes time, then so be it.

Some tips for you might include:

1. Read the Coast Guard Regulations (CG-300), article 8-5-3 for specific duties of Electrical Assistant, Auxilary Assistant, DCA, etc.
2. Read the Ship's Organization Manual for specific shipboard duties/functions.
3. Read the Engineering Department Organization Manual for additional specific duties.
4. Sit down with Chief SNAPDECISION and ask him what he thinks *his* job entails. Then ask him what he thinks *your* job should entail. Standby for some surprises.
5. Then take your place in the chain of command until you get "into" your Division Officer job.

If Chief SNAPDECISION continually gives you the "Buzz-off Boot-routine," he is not helping you or the Coast Guard. Unfortunately, as an Ensign there is little you can do to alter this philosophy. However, an appeal to his professionalism may be all that is needed. Perhaps something like:

1. I'm new and you're the man with the experience, so I'm going to need some guidance.
2. Chief, you're just the man I need to chat with about this problem . . . .

The fact that you're seeking his opinion (and rightly so) may soften those crusty old bones somewhat. Remember, getting the opinions of those who actually do the work is a cornerstone of good management.

The Division Officer role is tough. It's ground level indoctrination into what makes people tick. You'll keep tabs on work done and entering that work onto the Machinery History Cards. You'll keep looking ahead at future jobs, future parts, future money needs. You'll be writing marks on the people who work for you. MARKS ARE NOT TAKEN LIGHTLY. One of your questions to Chief GODFATHER should have been, "How do marks affect one's life?"

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Other Things

1. Additional weapons for setting your world aright include:

   a. Don't accept the word "they." "They" will never get screwed, but *you* will.

   b. When using the telephone, find out to whom you are speaking; get a *name*.

2. When reporting aboard, Service Dress Blues are always appropriate. Military courtesies are observed in the field, and from the moment of arrival, you will be observed too.

3. Collateral duties are many and varied. Look in the ship's organization book to find out what is expected for each. Your best advice is to take these jobs seriously. Look ahead to see how the ship's operations will affect your collateral duties. Anchoring in a polluted harbor may mean water hours, which means no laundry. Keep records. Be organized.

4. Some excellent publications are available from the Bureau of Naval Personnel (NAVPERS). Your training officer can order these free; some examples are:

   - Principles of Naval Engineering
   - Marine Gas Turbines
   - Diesel Engines
   - Basic Electricity
   - Basic Electronics
   - Engineman 3 and 2
   - Fireman's course

Well, That's It

Keep repeating the Student Engineer Oath, apply liberal doses of common sense and . . . good luck.

About the Author

LT Ira SANDPEEP is a fictitious character penned by LCDR Frank P. MURRAY. LCDR MURRAY is a 1968 USCG Academy graduate; he did his student engineering on the USCGC *Spencer*. Other tours of duty have included: USCGCs *Rockaway*, *Gallatin*, and *Mellon*; and G-ENE. In June 1979, he completed a Masters Degree in Naval Architecture and Marine Engineering at the University of Michigan. He is a registered professional engineer and is presently assigned as an instructor in the Engineering Department at the Academy.

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Coast Guard Installing New Operations Computer Center

—A sailing vessel has lost its mast and is drifting in the North Atlantic. Coast Guard search and rescue people need to know where the boat will drift and which units are ready to respond in the area.

—A tanker off-loading a hazardous chemical has started to spill. Coast Guard Captain of the Port officials need to know immediately the chemical's toxicity, flammability, and other properties in order to safely contain and clean up the spill.

—A container ship has left Tokyo bound for the Middle East. As it weighs anchor, it sends a telex to the Coast Guard's Automated Mutual-assistance Vessel Rescue System (AMVER) at Governors Island, New York, telling its course, speed, and other information.

A variety of situations; a variety of needs. All are now being handled by a number of Coast Guard offices spread around the United States.

Within a few years, a new computer system being installed at Governors Island will help solve these problems from a central location.

The backbone of the new Operations Computer Center will be two Prime Computer Inc. Model 750's. The twin computers will be able to store 300 megabytes (300 million characters) in each of their two memory banks; a total of 1200 megabytes or 1200 million characters of available storage space. The new computer will operate 10 times faster than the computer the Coast Guard is now using.

"This computer has all of the bells and whistles of the largest computers," said Lieutenant Hugh Grant, a project officer in the Information Systems Division of the Atlantic Area Command, which is responsible for the installation of the system. "But it has the economy and efficiency of a mini-computer."

Grant added that this system will tie to the Command Display and Control (COMDAC) systems being installed on the Coast Guard's new 270-foot class cutter.

The Operations Computer Center will also be able to track icebergs in the North Atlantic, keep data on foreign and US fishing vessels within the fisheries conservation zone (200 mile limit), and provide drift predictions for search and rescue operations and pollution studies.

The new system will help Captains of the Port and Marine Inspection Offices by providing a wide variety of vessel information. A past history of a ship's inspection and safety record will be stored in the computer, aiding enforcement of maritime regulations.

A hazard assessment program will help Coast Guard officials in responding to incidents involving toxic and hazardous substances. The computer will provide a description of the chemical properties to help safely contain the material.

The initial phase of the project will take about two years to complete. Included in the project will be a physical remodeling of the Governors Island facility and a fifty percent increase in the number of personnel assigned.

Approximately 300 terminals will be hooked to commercial data lines, enabling units all over the Coast Guard to talk to the computer. One of the immediate benefits of the new system will be increased flexibility in AMVER.

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AMVER tracks approximately 25 per cent of the world's merchant fleet. A vessel's size, speed, destination, and other information are entered into a computer which then can plot within 25 miles its daily position anywhere in the world.

This information is used by search and rescue people around the world to locate the vessel if it is overdue or ask the ship to come to the aid of a nearby distressed ship.

"There are a number of manual operations associated with the current AMVER system," said Grant. "These will be automated as the new system comes on line."

One of the biggest drawbacks of the current system is that it is tied to the Department of Transportation's computer in Washington, D.C. Data received at Governors Island from all over the world is collected, checked, put into a proper format, and sent to Washington by a data line. While the system has worked well since its inception in 1970, there have been problems dealing with a computer not dedicated to AMVER or Coast Guard use.

"The computer in Washington is primarily an administrative machine," explained Ensign Nancy Ross, AMVER's Chief of Maritime Relations.

"What this means is," continued Ross, "the computer has to be kept busy all of the time. When emergencies come up or rapid access is needed, work in progress has to be stopped to get dedicated service."

"The new operational computer will be able to respond to emergency queries immediately and users will be able to talk to the computer directly." The result will be increased service to mariners and search and rescue people.

Coast Guard Operations Centers around the country will have terminals that can interact directly with the main computer on Governors Island. This will provide them with more timely and accurate information on unit readiness and locations, in addition to AMVER information. Right now, operations centers depend on their telecommunications centers to get information from the Washington computer.

Eventually, say project officers, the new system will touch aspects of nearly all Coast Guard units According to Grant, the Coast Guard will install terminals in district headquarters and several Marine Inspection Offices first after trial periods in selected units. Plans call for the future installation of terminals in group headquarters (a smaller part of a larger district) and on board ships.

In a few years, the Coast Guard will have a service wide system to help perform its lifesaving and law enforcement missions quicker, more accurately, and with less expense.

LCDR Kelly CALLISON, Computer System Administrator, "talks" to the new Operations Center Computer through a teletypewriter. By typing on the machine, Callison can enter information, ask for information, or program the computer. Officials hope to have these devices installed all over the Coast Guard in the near future to help with a variety of tasks.

The Gray Engineer

Reprinted from *The National Fisherman*,
April 30, 1980, No. 13, Vol. 60

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I was down on the docks
Just spending my time—
Out of a job and not
Making a dime,

When up steps a man,
and
He says, "I suppose
You're an engineeer,
By the looks of your
clothes."

Well, he guesses me right
Or I'm a son of a gun.
"Do you happen to have
any
Tough ones to run?"

He says he has one that's
A tough one to start
And she won't turn over
'Til you take her apart.

He says this old engine
Hasn't ever run right
He's cranked her all day,
And he's cranked her
all night.

I get all excited and
Ask what he pays
To fix this old donkey
For the rest of her days.

He offers ten dollars and
I says, "I'm your man.
If anyone can start her,
I know that I can."

The engine ain't made—
No matter how dead—
That I cannot run 'til
She jumps off her bed.

He says, "Get your
wrenches,
I'll give you a chance."
I picked up my toolbox
and
Hitched up my pants.

We got in his dory and
Skulled off to his boat
And I didn't wonder that
Mill got his boat.

I looked down in the
bilges
And there she lay;
A lousy old, rusty old
Six-Ninety Gray.

She had Delco ignition
And Champion plugs
And was wet from her base
To her cylinder lugs.

I grabbed for the needle
And gave it a twist,
Rolled up my shirt sleeves
And spit on my fists.

I rolled her over and, well,
I knew then
That before she was started
I'd sure earn my ten.

She was all out of time
And her wires were shot
Her points didn't break
And her bearings were hot.

Her compression was poor
And her gaskets were punk.
You could tell at a glance
She was nothing but junk.

I pulled out the choke
And retarded the spark
And gave her a flip
Just to see if she'd bark.

She blew out a plug and
Went backward instead,
And I busted a carlin'
With the top of my head.

I took off the hand-hold
And looked at her crank,
Got hold of her throttle
And gave it a yank.

Checked up the valves
And tested the coil,
Then took off her timer
And soaked it with oil.

I cranked 'til my boot-tops
Ran over with sweat,
And not one explosion
From her could I get.

I took out the condenser
And filed up the points
And cranked 'til my
elbows
Flew out of their joints.

I primed her with ether
And called her a name—
She was dead as a
mackerel
And I was the same.

I tested the battery
And fiddled the switch,
And then I decided
The gas was too rich.

I swore 'til the paint
In the cabin turned green.
A tougher old junk pile
I never have seen.

I says, "I'll be darned
If I know what to do."
And the captain says,
"Here, have a glass of
home brew."

That liquor was potent
And fragrant and hot.
I says, "That's the answer!
How much have you got?"

He hands me a jug
With a quart and a half.
I took out her plugs
And gave her a draught.

I poured what was left
In the gasoline tank,
Grabbed hold of the starter
And gave it a yank.

She made one explosion,
And that one was stout.
Her flywheel flew off
And her pistons flew out.

The base and exhaust pipe
Went up thru' the deck
The spark plugs and wires
Were wrapped 'round
my neck.

I was laid up in bed
For seventeen days,
And you can't hire me,
boys,
To start no more Grays.

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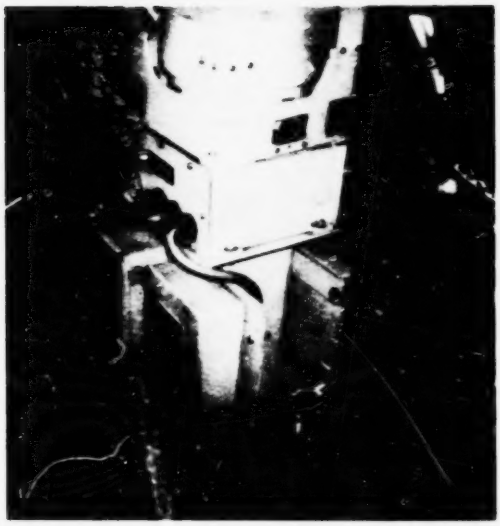
ENGINEERING NOTES
A Unique Gyrocompass Installation

EMCM K. S. Bradbury
Naval Engineering Assist Team
Thirteenth Coast Guard District



Upon receipt of the 17th District based "A" Class buoy tender *Citrus*, which is to replace the WMEC *Modoc* and to be redesignated a WMEC in the 13th District, it was determined to replace the outdated MARK 14 Gyro on the *Citrus* with a MARK 27 Gyro removed from the *Modoc*.

The new installation, as shown above, includes a custom made aluminum stand fabricated by Sperry Marine Systems, Seattle.

Previous installations of MK 27 Gyros have had peripheral control and alarm equipment located separate from the master gyro, sometimes in a different compartment.

With the stand furnished by Sperry it was decided to install all control and alarm equipment on the stand with the master gyro and electronic control unit. This equipment includes a MARK 37 gyro transmission unit, an alarm unit, the power transfer and power converter units. All work was accomplished by the 13th Coast Guard District Naval Engineering Branch Assist Team.

This unique configuration resulted in shorter cable runs, and will make for faster, more convenient system control and trouble shooting.

About the Author

Master Chief Electrician's Mate Kenneth S. BRADBURY is presently attached to the 13th Coast Guard District Naval Engineering Assist Team. His previous duty stations include: 7 years in the Navy, the WHEC's *Pontchatran* and *Mellon*, Loran Station Iwo Jima, the WLB *Magnolia*, the WAGB's *Staten Island* and *Polar Star*, and the 9th District (ene).

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Value Engineering by Contract

LTJG R. E. Kilroy
Civil Engineering Branch
Third Coast Guard District

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As the Third District prepared to hire an A/E firm to design a new Public Works Building for Support Center New York, the question of how best to apply the principles of Value Engineering to the design kept coming up. (The Project Manager just happens to be the Value Engineering Field Program Manager and the author of this article.) There were three options available: include a provision in the contract directing the A/E to Value Engineer the project; do an in-house V.E. study; or, hire an independent firm.

V.E. by the A/E

Requiring an A/E firm to Value Engineer its own design would be a violation of one of the basic precepts of Value Engineering—members of the V.E. team should have been uninvolved in previous design decisions. Even if the A/E supplied a V.E. team, comprised of uninvolved individuals, they would hesitate to be realistically critical of their own firm's design. Furthermore, the requirement that a firm employ the necessary number of experienced Value Engineers would make A/E selection criteria overly restrictive.

In-House

While a number of individuals on the district staff have received formal V.E. training, no one has yet achieved the status of Certified Value Specialist, qualifying him to direct and supervise a Value Engineering Workshop. Additionally, it would be very difficult to extract a staff member from each design discipline and collectively isolate them from the exigencies of ongoing business long enough to complete a V.E. Workshop.

Independent V.E. Firm

We decided to seek out the services of a firm specializing in Value Engineering. Specialization implied that the V.E. team would be thoroughly familiar with the methodology involved in the Team Approach and could devote its entire time to reviewing the project rather than acquiring the tools of the trade. Furthermore, V.E. experts contend that the same high cost items tend to appear in design after design and an experienced team can rapidly identify and suggest alternatives for these items.

The Scope of Services for the design A/E was written to include the following clause:

> "Value Engineering will be applied to this project. A basic concept of the Value Engineering Team Approach is that the members of the team should have been uninvolved in previous design decisions concerning the project. Therefore, a copy of 30% design submissions will be furnished by the Coast Guard to an independent V.E. firm which will conduct a 40-hour V.E. workshop. A representative of the A/E who is thoroughly familiar with the project shall attend this workshop to assist in obtaining pertinent information. A copy of the report provided by the V.E. firm will be returned to the A/E within three weeks. All recommendations contained therein and concurred with by the Coast Guard shall be incorporated into the final design unless rebutted by the A/E to the satisfaction of the Coast Guard."

Selection

GSA supplied us with a list of eleven firms which supposedly specialize in Value Engineering. A letter was written to each of

these firms which briefly described the project and asked them to supply us with qualifications if they were interested in and capable of performing the required 40-hour V.E. workshop. Of the eleven firms, only three responded. (Three letters came back marked "Undeliverable as Addressed, no forwarding order on file.") The respondent firms were rated on a variety of factors, and selection was made in accordance with DOT Procurement Regulations.

The firm selected maintains a separate Value Management Division, headed by a noted leader in the field.

Cost

Negotiations with the selected firm were based on the accompanying Scope of Services. The agreed fee for the 40-hour workshop, with preparation and post-workshop coordination of report preparation, was $13,360. Additionally, the contract with the design A/E included a fee of $4304 for attending the workshop and reviewing the report, bringing total cost of the V.E. effort to $17,664.00, not including our administrative expense.

The guidelines in Commandant Instruction M11000.1 (old CG-251) suggest expectation of a 2% reduction in project cost through the application of V.E. and a 10 to 1 return on each dollar invested in V.E. Using these criteria, the projected construction cost warranted an expenditure for V.E. of about $3300. Obviously, we exceeded this amount a bit, but, realistically, if we could generate about $20,000 in savings, we would break even.

Results

The recommendations of the V.E. consultants resulted in redesign or alteration of three major building systems with associated savings as follows:

BUILDING SYSTEM	SAVINGS*
Structural Frame	$32,670
Exterior Walls	$34,450
Mechanical	$27,620
	$94,740

Smaller savings were realized in a number of areas, but their dollar value is difficult to estimate. The TOTAL figure above represents a reduction in total cost of about 6%. Net savings to the Government were $77,076; return on investment about 5.4 to 1. All in all, not a bad deal.

*Based on 30% design and final design cost estimates, and final design total square footage.

Preliminary Scope for V.E. Workshop
Public Works Building
Governors Island, New York

1. *General Requirements.*

   1. Assemble a multidisciplinary team composed of at least one architect, structural engineer, mechanical engineer, and electrical engineer, with other support as necessary, and conduct a 40-hour Value Engineering workshop.
   2. All members of the V.E. team must be experienced in the methodology of Value Engineering.
   3. Three copies of the final report of workshop findings and recommendations shall be forwarded to the Contracting Officer within ten days of receipt of data package.

2. *Purpose*. The purpose of this study is to review the 30% design submitted for the Public Works Building and develop cost reduction proposals to effect immediate and life-cycle savings to the Coast Guard. The objective is to achieve required performance, reliability and maintainability at the lowest overall cost without compromising the functional requirements of the project. Proposals for cost reduction will be incorporated into a final report.

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3. *Background.*
   1. The Public Works Building will be a 28,600SF structure to house all Public Works shop and administrative functions on Governors Island. Public Works has responsibility for maintenance of all facilities on Governors Island.
   2. The A/E selected for this V.E. Workshop will be supplied with the 30% design submittals from the A/E designing the building, including design data sheets, 30% design drawings, outline specifications, and preliminary cost estimates.
   3. A representative of the design A/E who is thoroughly familiar with the project will attend this workshop to assist in obtaining pertinent information.
4. *Scope of Services.*
   1. Review cost estimates and isolate areas of relatively high cost.
   2. Develop alternate methods to reduce life-cycle costs in these areas.
   3. Recommend chosen alternatives and validate to the maximum extent possible.
   4. Prepare a final report of findings, including finished proposals for cost reduction.

About The Author

LTJG Ron KILROY received a B.S. degree in Business Administration and Economics from Arizona State University. He was commissioned in December 1976, after completing OCS, and has since served as a Project Engineer and Value Engineering Field Program Manager at CCGD3(ecv). LTJG KILROY was recently selected for Postgraduate Education in Law.

Chief Engineer's Comments

The Third District (ecv), in general and LTJG KILROY in particular, should be complimented for their contribution to the Coast Guard Value Engineering Program. Consistently, the Third District has shown remarkable savings, through the application of value engineering. The Third District, in their FY-79 Value Engineering Summary, reported nearly $400,000 in savings attributable to the application of value engineering, during design, and nearly $4,000,000 since value engineering savings were first reported in FY-71!

Historically, the lack of personnel with formal value engineering training and the availability of personnel for a multidiscipline team have been major road blocks to a successful value engineering program. The approach illustrated in this article is an innovative technique to eliminate these road blocks. Contractual arrangements, such as stated in this article, are actively encouraged.

Commandant (G-ECV) is currently engaged in developing a contractual arrangement to facilitate district and Headquarters units' utilization of contract value engineering services. Details of this arrangement will be published as they are developed.

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Airborne Remote Instrumentation (AIREYE)

LCDR Ray McFadden
Aeronautical Engineering Division
U.S. Coast Guard Headquarters

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In 1978, a total of 11,816 pollution incidents occurred in the coastal waters of the United States. These incidents resulted in over 14 million gallons of oil being spilled in our waters. The extent of the problem in numbers of incidents, volume of oil spilled, and the vast extent of the coastal areas involved, requires a wide area surveillance system to provide early detection of oil spills. The Coast Guard has conducted research in both aircraft and spacecraft remote sensing systems for oil detection. Early research in the infrared/ultraviolet, visible, and microwave areas of the electromagnetic spectrum have proven that detection, identification, and quantification of oil spills is feasible. In order to provide the desired all-weather, day/night capability to ensure maximum coverage and reliability, a multisensor system approach was taken. The initial hardware developed was the Airborne Oil Surveillance System (AOSS), and was flown on the HU-16E. Further development and refinements resulted in an AOSS II which is installed on the modified C-130 CGNR 1347.

The success of the experimental systems and AOSS II have led to the development of the Airborne Remote Instrumentation System (AIREYE). The AIREYE is being designed and developed for installation on our new HU-25A Falcons. Currently we are acquiring six AIREYE systems that will have the capability of detecting, mapping, and identifying oil spills and illegal discharges. All forty-one of the MRS aircraft are being modified to accept the entire AIREYE sensor system. The system will consist of:

- Side Looking Airborne Radar (SLAR)
- Infrared and Ultraviolet Line Scanner (IR/UV)
- Aerial Reconnaissance Camera (KS-87B)
- Active Gated Television System (AGTV)
- Airborne Data Annotation System (ADAS)
- Control Display and Record Console (CDRC)

The SLAR to be integrated into the AIREYE system is a new generation of the AN/APS-94 which has been in the DOD inventory in various forms for the last 15 years. It is currently being manufactured by the Motorola Corporation and has been redesignated the AN/APS-131. The principal improvements in the AIREYE SLAR over previous Coast Guard SLARs are:

- Peak power increased from 40 to 200 Kilowatts
- Built-in test equipment
- Latitude/longitude calculations
- Microprocessor radar system timing circuits
- Dry-silver film processor
- Latitude/longitude lines superimposed onto film
- Eight foot, HU-25A compatible, antenna

The new "state-of-the-art" 8-foot antenna will be a back-to-back dual array antenna capable of simultaneously mapping from both sides of the aircraft. It will be yaw stabilized and mounted slightly off center line on the right hand side of the fuselage. The SLAR has been the long range and key search sensor in previous sensor systems and is envisioned to continue this role with the AIREYE system. The SLAR can produce excellent imagery in most weather conditions, and is unaffected by clouds. The output imagery of the SLAR is a wide area map on 9-inch dry-silver film and video

tape. It can also be viewed on the multi-purpose display in the aircraft.

The IR/UV Line Scanner has a twofold purpose in the AIREYE system. It is used to scan the area directly below the aircraft that is missed by the SLAR, and to make positive identification of oil detected by the SLAR. With these three different data inputs (IR/UV and SLAR), wake scars, kelp beds, etc., can be differentiated from oil slicks. The output from the IR/UV line scanner will be recorded on 4.5-inch dry-silver film and video tape, just as the SLAR imagery. The optical/mechanical portion of the IR/UV line scanner will be in a pod mounted on the starboard wing.

The aerial reconnaissance camera (KS-87B) is presently in DOD inventory. It is a pulse operated frame camera containing interchangeable lens cones, a high speed focal plane shutter, automatic exposure control, data recording, and forward motion compensation. The film will be contained in interchangeable cassettes and hold approximately 500 feet of 4.5-inch film. The camera will "look" through an optical window built into the port side, even with the bottom of the cabin door, between the cockpit and the cabin door.

The Active Gated Television (AGTV) will provide the needed nighttime identification feature that is currently lacking in the AOSS II system. The AGTV will be pod mounted under the port wing. In the passive mode it will function as an extremely low light level television with a maximum field of view of 18 degrees. As the aircraft approaches the ship at approximately 500 feet and 160 knots the field of view is reduced to 6.5 degrees, and finally to 2.3 degrees. At a slant range of 2.5 miles the AGTV is switched to the active mode. In the active mode the laser illuminator is brought into play. The laser is pulsed (15-20 nanosecond duration), and after a time equal to range of the computer-determined distance to the target and back, the television camera is gated "on." The ability of the extremely sensitive camera to "look" at the light when it is only on the target increases the contrast, resolution, and definition of the TV image. The imagery will be presented on the multi-purpose display and recorded on video tape. This will enable the operator to play back the passes on the target to ensure that the identity has been positive.

The AGTV can be operated in either the computer track, manual track, or automatic track mode. In the computer track mode, the gimble angle is controlled by the AIREYE computer after adjusting for the aircraft's motion. In the manual mode, the sensor operator has direct control of pointing the AGTV either with a track ball or a joystick. In the automatic mode, a correlation tracker, in effect, memorizes a scene and stores its location in a digital memory. As the aircraft moves, the location of the scene is moved in the memory circuits, and the gimbles are moved to keep the tracked scene in view. Targets can be tracked up to one radian per second.

A correlation tracker is particularly necessary because it allows the AIREYE system to remain "locked on" a target while positive identification of the vessel is recorded. The correlation tracker can maintain track with as little as 15% scene contrast.

The airborne data annotation system is a key element in the production of the imagery because altitude, latitude, longitude, etc., data will be directly superimposed in a data block on the IR/UV and camera film. This will provide positive proof of the aircraft's position and time for those scenes recorded and entered as evidence in legal cases. The SLAR has an internal data annotation provision, and will provide this data annotation for itself and the multi-purpose display.

The Control Display and Record Console (CDRC) is the central control point for the AIREYE system. The "heart" of the CDRC is the sensor computer. The computer will perform five primary functions:

- Automatic pointing of the AGTV
- Generation of a map displaying sensor and target positions
- Implementation of display and control

functions

- Digital interface of the ADAS to the aircraft
- Monitoring of sensor and system performance and failure

The Control and Display Unit (CDU) is used by the system operator to enter alphanumeric data into the computer. The CDU can also display abbreviated maps as well as alphanumeric data and is physically identical to the aircraft's CDU in the cockpit. The display functions which will be available to the operator are:

- Real time imagery from the SLAR
- Real time AGTV imagery
- A computer generated map
- A moveable cursor and vector line to designate targets
- Full resolution stop-action/freeze-frame

recording and playback control

Presently, the system is planned for Air Stations Cape Cod, Elizabeth City, Miami, Mobile, and two at Sacramento. The operators will be ATs and AEs specifically trained for the job. Initially there will be eight trained operators. The training will be conducted by the contractor who integrates the AIREYE with the MRS aircraft. This contract has been awarded to the Aerojet Corporation located in Los Angeles. The first operational aircraft is expected to be delivered during the summer of 1982, with the following five to be delivered starting in the summer of 1983. Mission requirements have not been totally developed as yet, but should be known by the time the systems are placed in operation. As the system develops, an update will be provided through various media. Specific details may be obtained from LCDR Ray McFADDEN, COMDT (G-EAE), FTS 426-0796.

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From the Editor

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- Thank you for the many calls received in response to the Fall issue. We were pleased to hear that the overwhelming majority liked what they read. We also received 1 letter (the only one this year) from an author who was less than pleased with the Commandant's Comments. (Note: With this issue Chief Engineer's Comments will be used instead of Commandant's Comments.) These comments are written by the same people who review articles for technical content. They need your input as well as we do; so, please, keep those letters, calls, etc., coming. Here is the letter we received:

To: Editor, **Engineer's Digest**
Ref: "Organizational Structure, Impact on the Construction Team," LT R.A. Stromsted, Engineer's Digest, Fall '80

The "Commandant Comments" surprised a number of my First District Civil Engineering colleagues and me. I wonder if the author of "Comments" even read the article, since a discussion of the article's heart-issue, Organizational Structure, was completely avoided. What are the opinions toward joining the Contracting Branch and Engineering Division within districts? And, would the Coast Guard enjoy smoother construction projects if we implemented a project manager lead-role?

I also noticed that the "Comments" opened by stating ". . . the final quality of a Coast Guard Facility can be *determined* through our inspection program. . ." I actually said "that the final quality of a Coast Guard Facility *is influenced* by our inspection program. . ." The success of any construction team is influenced by countless factors such as experience, education, personalities, leadership abilities, and the way in which team members are organized.

Guiding readers away from the article's central theme, the "Comments" continue ". . .The role of the inspector is to insure compliance with the contract documents, not to improve the quality to make up for design deficiencies. It is wrong for the Government to demand more from a contractor merely because it is a 'Government Job'." I agree. Hopefully and probably, organizational and project leadership adjustments will increase our chances of not falling into these and other construction-phase problems.

To explain the contents of "Comments," I can only surmise that a Civil Engineering committee wrote the "Comments" (first draft), an inspection staff edited it, the Civil Engineering committee reviewed it, and the Procurement Staff rewrote and approved it.

ROBERT A. STROMSTED

- If you're interested in oil pollution control, here is the right thing for you: the 1981 Oil Spill Conference. The Environmental Protection Agency, American Petroleum Institute, and the U.S. Coast Guard are sponsoring this conference, the only U.S. Conference specifically for oil spills, to be held March 2-5, 1981, at the Atlanta Hilton Hotel, Atlanta, GA. The Conference theme is Prevention, Behavior, Control, Cleanup. It will feature exhibits, films, and many CG papers. For further information contact:

1981 Oil Spill Conference
Suite 700
1629 K St., N.W.
Washington, D.C. 20006 USA
(202) 296-7262

- Other dates to note:

January 20—Call for papers. Eighth Ocean Energy Conference-81; Department of Energy and Marine Technology Society (MTS) Conference; Capital Hilton Hotel; Washington, D.C.; June 7-11, 1981. Contact: Technical Committee Chairman; Eighth Ocean Energy Conference; Marine Technology Society; 1730 M St., N.W.-Suite 412; Washington, D.C. 20036.

February 1—Call for papers. Oceans '81; MTS and Institute of Electrical and Electronic Engineers Conference; Boston Sheraton Hotel; Boston, MA; September 16-18, 1981. Contact: Oceans '81; Technical Program Committee; P.O. Box 132; Portsmouth, RI 02871.

February 1—Call for papers. Environmental Stress Screening of Electronic Hardware (ESSEH); Institute of Environmental Services (IES) 2nd National Conference and Workshop; San Jose Hyatt House; San Jose, CA; September 21-25, 1981. Contact: August L. Lena, ESSEH Technical Program Co-Chairman; Hughes Aircraft Co.; Bldg. 21, Mail Station M116; Centinela and Teale Streets; Culver City, CA 90230; (213) 391-0711, Ext. 4944.

February 27—"Emerging Environmental Solutions for the Eighties"; IES 27th Annual Technical Meeting; Marriott Hotel; Los Angeles, CA; May 4-7, 1981. Contact: Dr. Halsey B. Chenoweth; Technical Program Chairman; Westinghouse Electric Corp.; P.O. Box 746, MS 454; Baltimore, MD 21203; (301) 765-6179.

April 21-23—"Innovation for Maintenance Technology Improvements"; Mechanical Failures Prevention Group and Naval Air Systems Command Joint Symposium; National Bureau of Standards; Gaithersburg, MD. Contact: Mr. A.J. Koury (AIR-4114C); Naval Air Systems Command; Washington, D.C. 20361; (215) 692-9193.

- Incidentally, LCDR C.J. WALTER (then a LT), Planning and Evaluations Staff, USCG Headquarters, wrote an article called "Contributions to the Engineer's Digest." (See Summer 1979, No. 203.) After analyzing 5 years of the Digest from Winter 1974 through Fall 1978, he concluded, ". . . the typical author is a CG LT. He writes mostly on civil engineering and engineering management. . ." Although our analysis has not been nearly as complete, it appears that the number of articles from engineering-related sources has increased. The number one area of concentration is naval engineering with civil engineering following close behind. The other engineering disciplines are in a three-way battle for third place. Accordingly, special thanks to the leaders of the pack; and to the rest, let's catch up.

- Finally, we're having a hard time finding slides and photographs that are especially representative of the Coast Guard. We need photographs showing CG people at work: good engine room shots, boat haulouts & construction (especially 270's), tower erections (such as the Jan Mayen), etc. We also need shots of the various CG facilities. If you have such visuals, or know where we can get them, please let us know. The best submissions may be published later. Thanks for all your help.

Janis

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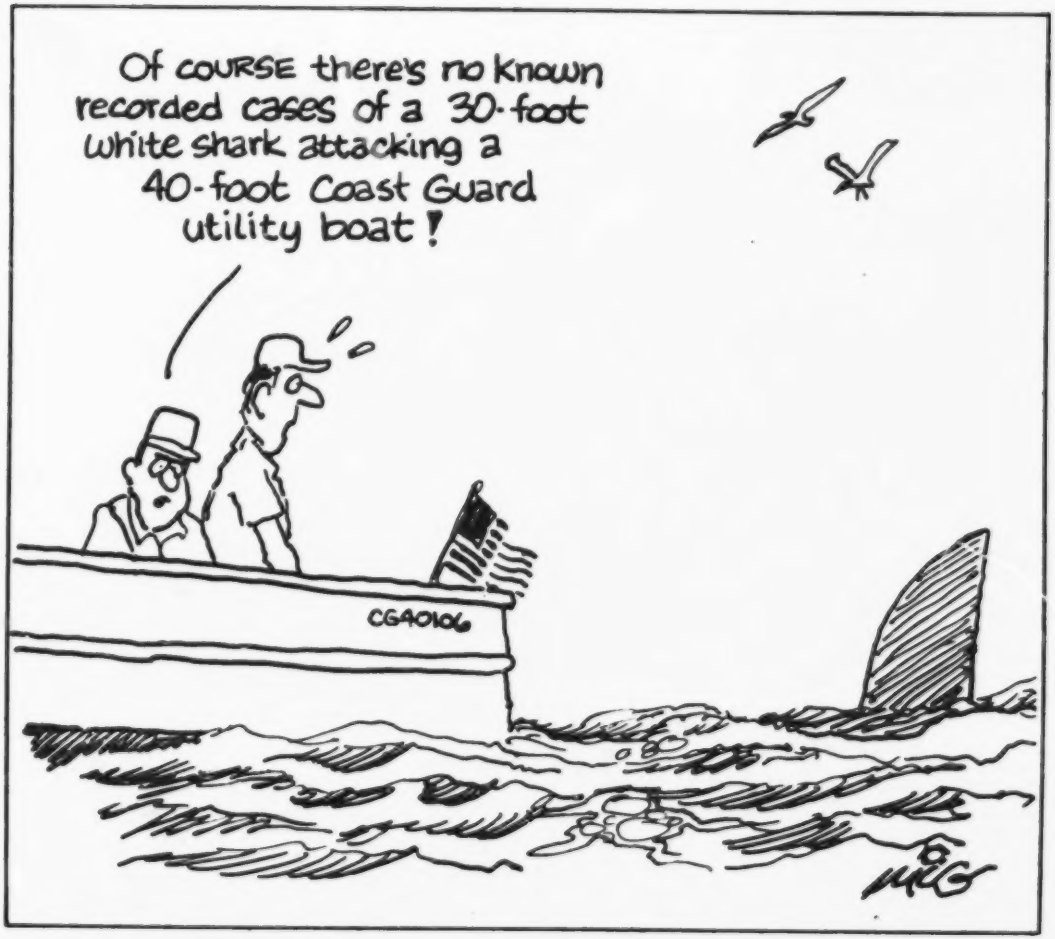

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